APR 4 1913

Engineering News

Issued Every Thursday
Hill Publishing Company

NEW YORK, APRIL 3, 1913

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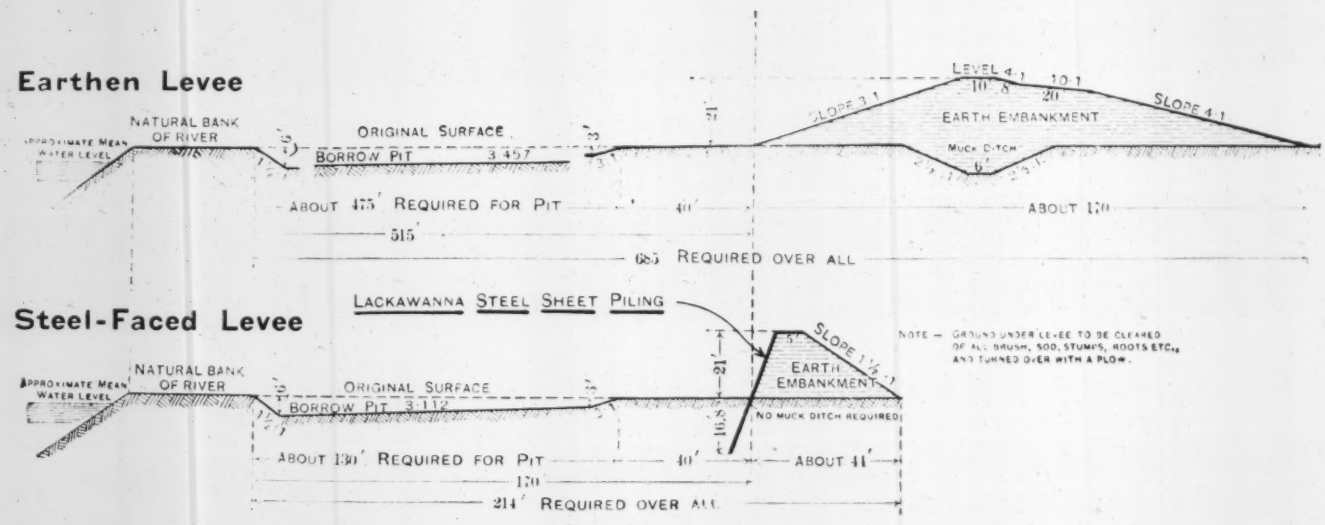

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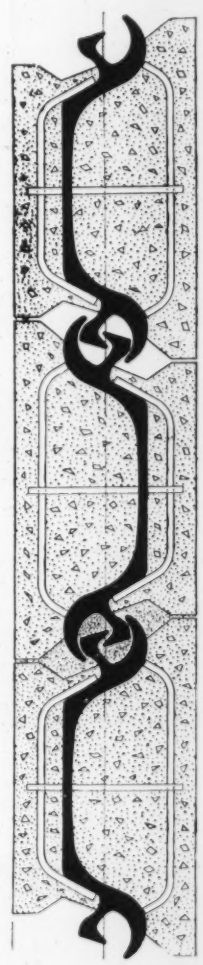

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Engineering News

CHARLES WHITING BAKER, *Editor*

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

Published Weekly By HILL PUBLISHING COMPANY
505 Pearl Street, New York, N. Y.

JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
Cable Address: "ENGNEWS"

To foreign countries, including postage, $9.00 or its equivalent, 38 shillings; 38 marks; or 45 francs. Notice to discontinue should be written to the New York Office in every instance. Advertising copy should reach New York Office by Thursday of week before date of issue. Entered at New York Post-office as mail matter of the second class.

VOLUME 69 APRIL 3, 1913 NUMBER 14

CONTENTS

WITH PRINCIPAL ARTICLES SUMMARIZED

*Illustrated Article

*MAKING A CUTOFF WALL BY GROUTING FISSURED ROCK, LAHONTAN DAM: *Page* 647

Describes the earth dam across the Carson River, in Nebraska, a part of the Truckee-Carson Project, U. S. Reclamation Service; character of foundation; bore holes and tests of; method of grouting rock. 3500 w. 9 ill. D. W. Cole. ENGINEERING NEWS, Apr. 3, 1913.

*TOPOGRAPHIC SURVEY OF CINCINNATI, OHIO: *Page* 652

Description of the topographic survey of a thickly settled city for the improvement of a comprehensive sewerage system, giving various steps, the triangulation, measurement of base line, precise levels, traverse work and planetable work in detail. 3000 w. 7 ill. Hugh C. Mitchell. ENGINEERING NEWS, Apr. 3, 1913.

*GREAT STEAM-ELECTRIC POWER PLANT: *Page* 657

Description of the proposed new Northwest electro-generating plant of the Commonwealth Edison Co., Chicago, Ill.; special features and plans for an immense station of 240,000 kw. capacity, with turbo-generators of 20,000 kw. each; rapid development in electrical machinery; abstract of paper before the Western Society of Engineers. 3000 w. 4 ill. W. L. Abbott. ENGINEERING NEWS, Apr. 3, 1913.

ANNUAL MEETING OF THE ILLINOIS WATER SUPPLY ASSOCIATION: *Page* 660

Papers and discussions at meeting held at Urbana, Ill., Mar. 11 and 12. 3000 w. ENGINEERING NEWS, Apr. 3, 1913.

COST AND MAINTENANCE OF STONE BALLAST: *Page* 663

Results of an investigation made by the Pennsylvania R.R. 500 w. ENGINEERING NEWS, Apr. 3, 1913.

*NEW RAILWAY FREIGHT TERMINAL AT ST. LOUIS: *Page* 664

Description of reconstruction and remodeling of the freight terminal of the St. Louis Southwestern Ry. in St. Louis, Mo.; five-story freighthouse, designed for handling freight by trucks to secure high degree of efficiency. 4000 w. 6 ill. ENGINEERING NEWS, Apr. 3, 1913.

*FORESHORE PROTECTION BY REINFORCED-CONCRETE GROINS: *Page* 668

Description of method of protecting foreshores against erosion by the use of groins or jetties; successful reinforced-concrete groins near Brighton, Eng.; based on paper before the Institution of Civil Engineers by J. S. Owens and F. J. Wood. 3500 w. 3 ill. ENGINEERING NEWS, Apr. 3, 1913.

JAPANESE ENGINEERING COLLEGE: *Page* 670

Describes the organization and work of the Imperial University of Tokyo; officers, degrees, school year, student regulations, engineering courses, practical training. 1500 w. ENGINEERING NEWS, Apr. 3, 1913.

*NOTABLE RESERVOIR FOR FLOOD CONTROL IN GERMANY: *Page* 672

Description of the Boder dam and reservoir at Alauer, Germany; largest dam in Europe; drainage area of 467 sq.mi.; reservoir of 593 acres; masonry dam 203 ft. high. 3000 w. 5 ill. Kenneth C. Grant. ENGINEERING NEWS, Apr. 3, 1913.

*REMINISCENCES OF A PIONEER ENGINEER OF THE GREAT NORTHERN RY.: *Page* 674

Recollections of an engineer connected with the early development of the Northwest; biographical sketch of the late Charles A. F. Morris, once Chief Engineer of the St. Paul & Pacific R.R.; early history of the Hill lines in Minnesota. 1200 w. 1 ill. (Contributed). ENGINEERING NEWS, Apr. 3, 1913.

*50-TON LOCOMOTIVE CRANE: *Page* 675

Description of a locomotive jib crane ordered by the U. S. Navy Department for the Brooklyn Navy Yard from the Browning Engineering Co. 500 w. 1 ill. ENGINEERING NEWS, Apr. 3, 1913.

BILL TO PROVIDE FOR STATE WATER CONSERVATION AND STATE CONTROL OF DAMS IN PENNSYLVANIA: *Page* 676

Features of the proposed legislation that are of the most interest to engineers; water conservation survey of state; supervision and control of the construction of dams and reservoirs; examinations of; State Water Commission, powers of. 2000 w. ENGINEERING NEWS, Apr. 3, 1913.

APPRAISAL OF WATER-WORKS PROPERTIES: *Page* 677

Abstract of a paper read at the annual meeting of the Illinois Water Supply Association; four methods employed; full details on the "reconstruction" method. 2500 w. Douglas A. Graham. ENGINEERING NEWS, Apr. 3, 1913.

FLOOD DISASTERS IN OHIO AND INDIANA: *Page* 680

Editorial discussion of the disasters from an engineering point of view. 2500 w. ENGINEERING NEWS, Apr. 3, 1913.

OMAHA, NEB., TORNADO: *Page* 692

Description of damage done by the severe windstorms of Mar. 23, from a personal investigation by a member of the editorial staff. 2500 w. 10 ill. ENGINEERING NEWS, Apr. 3, 1913.

EDITORIAL: *Page* 679

LETTERS: *Page* 683

ENGINEERING NEWS OF THE WEEK: *Page* 698

PERSONALS: *Page* 699

ENGINEERING SOCIETIES: *Page* 700

CONSTRUCTION NEWS: *Page* 43

CONTRACTS TO BE LET: *Page* 61

WANT ADVERTISEMENTS: *Page* 66

ADVERTISING INDEX: *Page* 144

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What The Buyer Needs To Know

Number Fourteen

"Three illusions are common to nearly all men. Nearly every man thinks that he thoroughly understands human nature, that he can run the local newspaper better than the editor runs it, and that he can write advertising."

So delivers himself a prominent national advertiser—who is besides, we might add, a keen analyst of his fellow-kind, with some right notions on advertising in general.

"That he can write advertising!"

You all have heard and perhaps know some specimens of the fellow who thinks he could make Greeley, Dana, Pulitzer & Co. look like twenty-nine cents in the newspaper game (if he only wanted to)—and you know the other fellow, who believes he can read and interpret, without a miscue, all the motives, actions and secret thoughts of the folks next door.

But—the man who thinks he can write advertising if he only wanted to—he's a newer phenomenon. New, probably, because advertising in the right sense is itself more or less new.

Why is it so many people think they can write advertising, especially those who, able or expert in some other line, really haven't the least qualification or aptitude for the job?

Because advertising is thought of as authorship—as writing.

We're a nation of authors. Go past the newsstand for proof. Doctors, lawyers, merchants, thieves, professors and old ladies—write. If a financier or a second-story operator is laid up at home with the gout or laid out at home with a billy, he fills in the enforced leisure by writing a book—about something. Novel, poem, play, essay, book of travels, "true" story of somebody, "appreciation" or damnation, *something* about *something*. And everybody reads—reads—reads.

Thus, it is easy to account for such widespread belief—or conceit—in ability to write advertising, when advertising is looked on as "authorship."

But consider a moment—

These tons of cheap, hurriedly, ignorantly written novels, stories, plays, etc., that stack the newsstands—people are not really *influenced* by reading such. Such stuff is bought to fill in the time, exactly as a lot of it is written—because the writer didn't have anything else in particular to do.

Now, *advertising* that is *written* in this way, will be *read* in this way.

But, let us whisper you this—

Real advertising is *only incidentally* writing. It is salesmanship that simply happens to be talking *per* the printed page—"happens to be," because it found a magnificently big opportunity to talk thus *through the eyes* of ten thousand humans at once instead of *through the ears* of the ten thousand in succession—if it could find 'em.

Of course, let us hasten to say, advertising has not shoved the real genus homo salesman out of his job, any more than the telephone has abolished letter writing; for, as the telephone simply does more swiftly and cheaply a myriad of things the letter used to do, leaving the letter to confirm, to clinch the bargain, so with advertising and the salesman—who lands the prospect that the ad. fishes up, who closes the sale that the ad. begins, and who does some certain other things only a thinking man on two legs can do. One great advantage of advertising over the salesman system simon pure, outside of its superior economy, is that advertising *discovers possibilities of business* in places where the salesman never dreams of looking.

But we're talking just now about *writing* ads.—and the gist of it all, with which we end is, "these"—

An Ad., "as is one," can't be written by the fellow who hasn't in him the spark of firing others to action—feeling-action, thought-action—any more than the Odyssey could be written by the office boy. The real ad-man, ad-builder and ad-dreamer, instead of and far from being a mere pen-shover, is—75% of him at least—that vivid, imaginative, dynamic genius of this modern time—SALESMAN.

Engineering News

VOLUME 69 APRIL 3, 1913 NUMBER 14

Making a Cutoff Wall by Grouting Fissured Rock, Lahontan Dam

By D. W. Cole*

The Lahontan Dam, now under construction by the U. S. Reclamation Service as a part of the Truckee-Carson Project, is located across the Carson River, in Nevada, just downstream from the discharge terminal of Truckee Canal, which with a capacity of 1200 sec.ft. brings water from Truckee River, 31 miles distant, for supplementing the flow of the Carson.† The dam will consist of an earth embankment having a length of 1359 ft., a maximum height of 124 ft., and a volume of about 750,000 cu.yd. It will form a storage reservoir with a capacity of 290,000 acre-feet, utilizing the water to

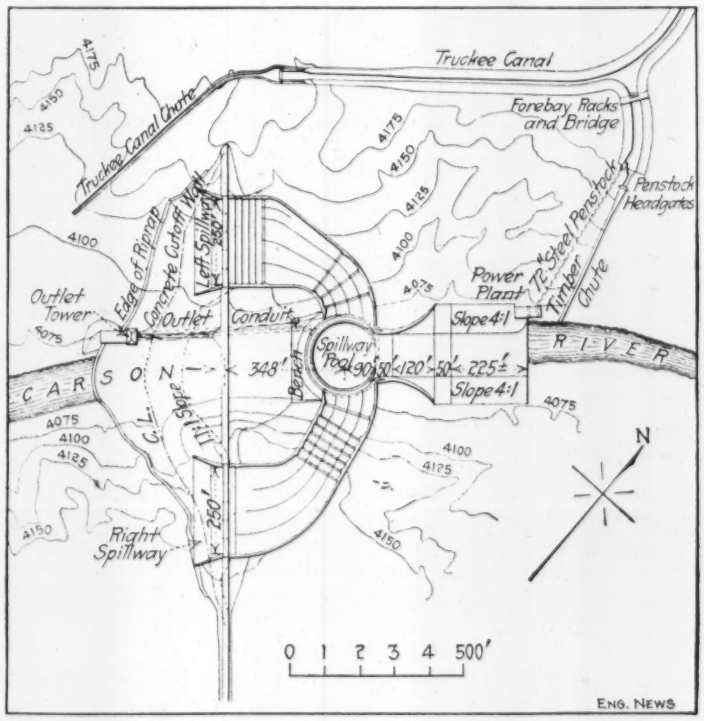

Fig. 1. Map of Lahontan Dam Site, Truckee-Carson Project, U. S. Reclamation Service

irrigate that portion of the Truckee-Carson Project, about 150,000 acres, which can be watered by gravity flow from the reservoir. The embankment is to be 20 ft. wide on top with an upstream slope of 3 to 1 protected by 2 ft. of riprap, and a downstream slope of 2 to 1 protected by 1 ft. of riprap. Near the upstream toe is a cutoff wall, the construction of which is described in this article.

The Foundation

The river at this location has cut a gorge which presents only a fairly good dam-site. There are two geological formations, the upper being of lacustrine deposits laid down by the ancient Lake Lahontan, which, previous to human history, flooded a vast area of which the nearby Carson Sink is one of the few remaining wetted remnants. These sands, gravels and marls of the old lake bed overlie a curious and more ancient sedimentary rock in which the dam is founded.

The rock in general resembles red sandstone; the geologists designate it "mudstone." Portions of it are very hard and close grained like marble. From this condition of induration and density it varies by imperceptible gradations to a tough red clay, and even to an unstable sandy clay.

Between these extremes there are all degrees of firmness, the hard rock being infinitely veined so that it breaks readily into angular fragments from a cubic yard to a cubic millimeter in size, while the clay is granular or amorphous by turns. In arrangement there are all sorts of intermixtures and stratifications, with hard conglomerates carrying egg-sized "pudding stones," soft clay seams separating layers of hard rock, with the various resulting "breakfast bacon" types of formation.

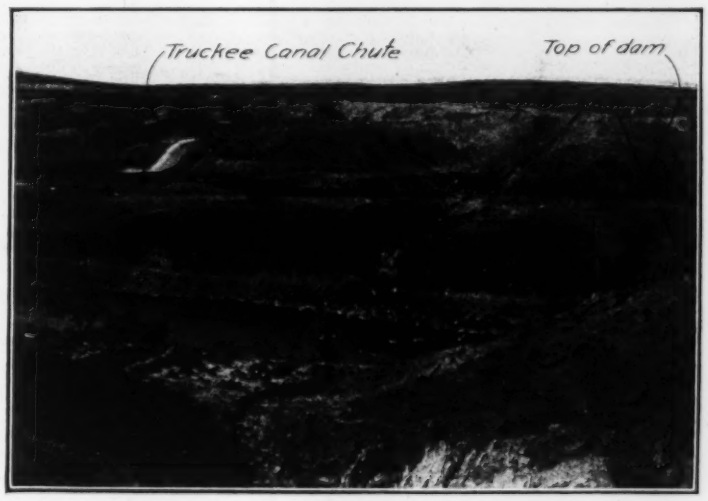

Fig. 2. View Looking across Lahontan Dam Site

The stratification dips from a nearly horizontal position to about 24° and is folded and faulted to a marked degree. Faulting ranges, in all directions, from an infinitude of slips measured in inches, or smaller units, to a few throws of several feet. The clay in the trenches cuts like cheese, exposing faces in nearly all shades of the spectrum, red and yellow predominating.

Fissures and thin veins in the rock are usually filled with clay or siliceous cement, but in general the rock is not impervious and water-bearing passages of small or moderate capacity are of frequent occurrence. The immediate river bed is in fairly continuous rock, laced with ¼ in. of smaller fissures irregularly displaced by faults, with occasional clay strata a few inches in thickness.

*Project Engineer, U. S. Reclamation Service Truckee-Carson Project, Fallon, Nev.

†See "Engineering News," Oct 18, 1906, p. 391, for description of the Truckee-Carson Project

Design of the Dam

Much study was given to the character of structure which could be safely be built on this foundation to withstand a reservoir head of 120 ft. The original proposal of a gravity masonry dam was abandoned, and finally the embankment type with deep cutoff wall was adopted, as illustrated in cross-section in Fig. 3.

In sinking the cutoff trench across the river bed it was found that the proposed depth of 50 ft. could be reached only by great expense for sheeting, bracing and pumping, attended by delay which might seriously derange the construction program. The design was therefore changed to provide for a 30-ft. trench, which could be excavated at reasonable expense in available time, with a view to placing vertically in the concrete cutoff wall, footed at this depth, galvanized well casing (Fig. 5) to facilitate the subsequent boring of the foundation below the bottom of the wall. Into the holes thus bored grout was to be pumped so as to seal effectually the strata below.

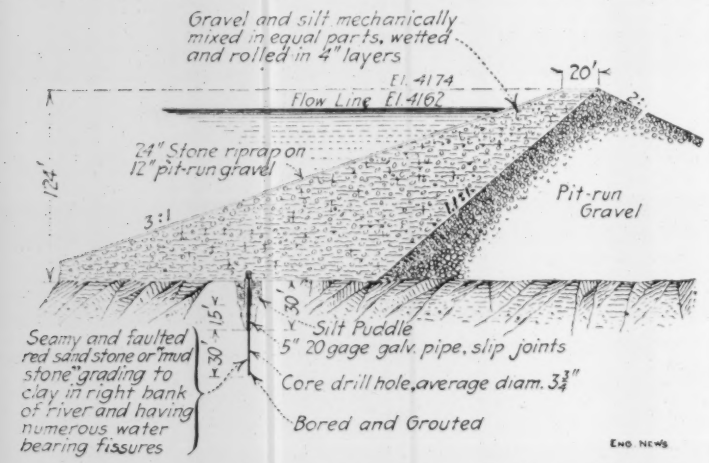
Gravel and silt mechanically mixed in equal parts, wetted and rolled in 4" layers
El. 4174
20'
Flow Line El. 4162
24" Stone riprap on 12" pit-run gravel
124'
3:1
1:1
Pit-run Gravel
30'
15'
30'
Silt Puddle
5" 20 gage galv. pipe, slip joints
Core drill hole, average diam. 3¾"
Seamy and faulted red sandstone or "mud stone" grading to clay in right bank of river and having numerous water bearing fissures
Bored and Grouted
ENG. NEWS

Fig. 3. Section through Lahontan Dam, Truckee-Carson Project, U. S. Reclamation Service

This plan was executed with the minor change of a minimum penetration of 60 ft., half of it by boring and grouting, instead of the 50 ft. of diaphragm wall originally proposed. This minimum was adhered to and at one point a depth of 100 ft. below river bed was reached and sealed with grout.

Boring the Holes

Equipment—Electric current in ample supply was available for all construction purposes from the power plant, in which the drop of Truckee Canal, 120 ft. into Carson River, is utilized at this site.

Electric-driven derricks were used in excavating the trench by hand-loaded skips and buckets. Vertical direct-connected motor-driven centrifugal pumps served to unwater the trench of the considerable inflow. A pipe line direct from Truckee Canal furnished water under head of 127 ft. at the bed of the river for all purposes, including testing the borings for leakage under more than reservoir pressure, constant supply for core drilling at adequate and uniform pressure and for grout mixing purposes. A small motor-driven air compressor furnished ample pneumatic pressure up to 100 lb. per sq.in. for operating the grouting machine. A duplex cylinder air-stirring grouting machine of the Canniff pattern was found very effective in forcing the grout into place.

Two drills were used, duplicates, manufactured by Ingersoll-Rand Co., of the "Class G-O" Davis Calyx type, using the calyx bit in the clays and the chilled shot equipment for the harder rocks. This is the smallest made of this type of drill. It is designed for manual operation but these two machines had been each fitted with a 5-hp. motor, giving practically double the capacity at less expense than hand work. Outside diameter of bits was 2⅜ in., inside $1\frac{13}{16}$ in., yielding hardrock core 1½ in. in diameter. (Fig. 4.)

Boring Procedure—Domestic wells throughout this section are usually cased with about 24-gage galvanized pipe 5 in. in diameter, in 30-in. lengths made by local tinners. This standard stock being available at considerably less cost than 3-in. wrought-iron pipe (which otherwise would have been used), it was assembled in 26-ft. lengths and erected vertically, footed on the rock in the bottom of the 30-ft. trench. These pipes were placed in a double row 2 ft. apart, on 3-ft. centers in each row, with positions alternating in rows so that transversely of the river there was a pipe every 18 in.

The pipes were securely held in position by T-shaped poles made of 2x4-in. stuff inserted in each pipe, while a light framework at the top and halfway down served to steady the battery of tubes in plumb position while concrete was poured into the trench surrounding them.

The coupling on the bottom of a 4-ft. length of 4-in wrought-iron pipe was thrust into the top of each 5-in. casing and thus completed the 30-ft. depth of drill casing, while serving the further purposes of making a concrete tight joint and a secure anchor for the pipe in the concrete when the grouting pressure was afterward applied.

Concrete was placed in the walls enclosing the casings as shown in Fig. 3. This work was done in two sections, the river being diverted as required. Following concrete placement in the first section the river was diverted over it, while the drilling and grouting were done from movable trestles about three feet above the water, with connection with each casing in turn.

Drills were worked continuously in 8-hr. shifts, thus employing six crews of two men each for operating the drills, with one daylight crew of two to four men for grouting and testing.

Drillrunners were selected mainly from the men of good mechanical bent available on the job, with one or two importations of experts who had been previously trained. Runners were paid 40c., and helpers 30c. per hr.

Daily bulletins were posted showing output of the several crews and thus a wholesome rivalry was developed.

The maximum depth drilled by one machine in 8 hr. was 19 ft., in rather soft material. The average 8-hr. penetration of a drill was only 6 ft. Omitting the earlier period of work, which was largely experimental, the average performance of each 8-hr. shift was about 7 ft. of hole.

There was much hindrance from seamy and caving ground, in which drills would frequently stick, and sometimes a whole shift would be lost in recovering the tools. In redrilling caved ground with shot drills there is difficulty and delay in holding the shot to the hit. In two holes the bits were lost by twisting off the rods, and in one case by pulling them apart with jack screws.

Cores of the penetrated strata were regularly taken where they were hard enough to hold together. Sections of core a foot long were unusual, most of them being ½ in. to 3 in. in length.

Testing Leakage of Holes

For determining the leakage of each hole, or, stated in another way the rate of percolation, under reservoir head, through the ground surrounding the boring, a test was made and a record kept of such leakage from every hole.

The pipe line from the canal was practically bottle tight and was connected in turn with each boring immediately after its completion. By manipulation of valves the water under 127 ft. head was turned into the boring and allowed 1 to 3 min., as found necessary, to fill all interstices and come to static pressure, or to a constant rate of flow which was too small to appreciably affect pressure.

The rate of leakage was found to be practically constant for each hole, though varying widely for different holes. Pressure was usually maintained for 10 min., or long enough to show any advance in rate of leakage.

The same method of testing was employed in "secondary" and "tertiary" borings, situated between borings that had been grouted, for showing decrease of leakage resulting from the adjacent grouting.

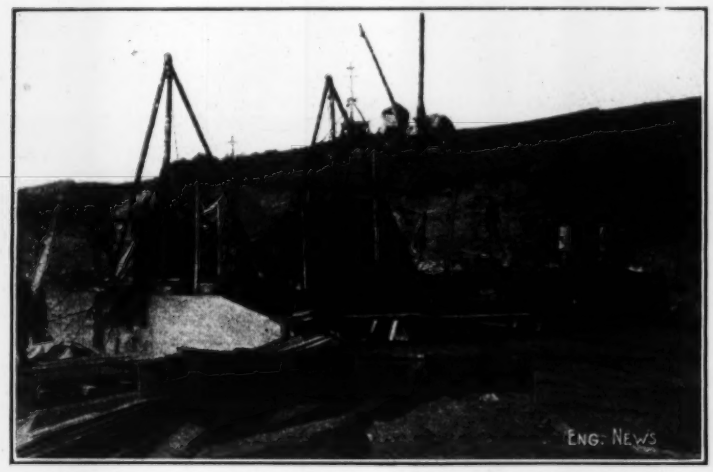

Fig. 4. Drilling Outfit at Work at Lahontan Dam

Grouting Process

Experience indicated a mixture of about 1 cement to 7 or 8 parts of water for the greater part of the work. At times when the grout seemed to get away too freely the mixture was thickened to nearly equal parts of cement and water, and in a few instances fine sand was added for filling apparently large seams or cavities.

Air pressure of 25 lb. was employed for first batches, as higher pressures sometimes resulted in appearance of air bubbles and even cement color rising from the bed of the river at some distance from the boring; and violent displacement of the formation was not desired.

As the grouting advanced the later batches were driven in at a higher pressure, gradually increasing to 100 lb. per sq.in. at the finish of each hole.

In some of the tighter holes the extreme pressure was required for an hour or more to drive home the grout, but ordinarily the flow of grout was nearly continuous and as fast as the alternating process with the double-cylinder machine could be performed. A view and a drawing of the grout machine are shown in Figs. 6-7.

The desired quantity of water was first put into the tank through an improvised gooseneck nozzle inserted in the line of hose and hooked over the top of the tank. Air was then admitted into the tank under the water which was thereby agitated for the required stirring effect. The cement being dumped in at this stage, the door in top of the tank was then swung upward against its gasket and held there by increasing air pressure while the mixing process was quickly completed. Meantime the mixture in the opposite tank was being discharged under any pressure desired, as shown by the gage in front of the operator.

With the disappearance of the grout from the telitale

Fig. 5. View of Well-Casings in Cutoff Trench

at the machine the valves were thrown, air pressure released from the empty tank, and the door fell by gravity. The gooseneck was then hooked on for the next charge of water. And so the process goes on until that particular boring cannot be charged further with grout under 100 lb. pressure.

To accelerate the setting of the cement in the fissures the grout was mixed in warm or hot water passed through a boiler for the purpose.

Order of Progress

The work divided naturally into two sections, conformably to the diversion of the river. In the "First Section" the alternate holes, 6 ft. apart, of the upstream row were drilled, tested and grouted. The drills then passed over the ground a second time to put down the intermediate holes, thus completing the borings on 3-ft.

centers in the upper row, the intention being to fill in to the 18-in. centers by boring and grouting the downstream row if results in the first row proved unsatisfactory. From the results achieved it appeared necessary to drill but few of the holes in the downstream row. In the "Second Section" the plan was adopted of first sinking each fourth hole, 12 ft. apart, then filling in the intermediates at 6-ft. intervals, followed successively by the quarters at 3-ft. spacing, the testing and grouting progressing in the same order (Fig. 8).

Results of the Work

Among other things it was observed that the grouting had a marked effect in stiffening up the adjacent ground, so that drilling of secondary and subsequent holes was performed with distinctly less difficulties from caving, with consequent clogging of drills. The horizontal seams in the rock were so thin that cement did not intrude in sufficient thickness for making a core which would withstand cutting by the drill in secondary holes. Furthermore the time between drillings was too short to permit hardening of grout in the seams sufficient for coring.

That the grout did harden, however, was proved by the cores taken from deposits which were forced into adjacent casings along the footing plane of the concrete wall. The

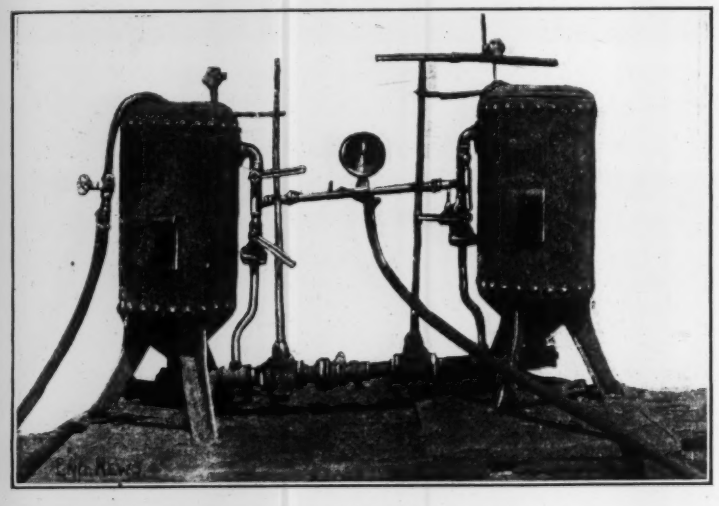

Fig. 6. View of Caniff Grouting Machine Used on Lahontan Dam

(Left-hand tank set for mixing; right-hand tank set for discharge.)

principal evidence of the effectual sealing of fissures and seams appeared in the progressive decrease in leakage as the work advanced from the first to the second, third and fourth sets of holes and also in the decrease of cement required for grouting the later holes.

The latter evidence is less consistent than the former, owing to various freakishness in the escape of grout into pockets formed by caving of the holes, or into casings of other holes, which would not have the same influence on the leakage test. This inconsistency, relatively unimportant, is more pronounced in work of the first section where methods were not at first standardized and less skillful interpretation of results was possible. But in the second section, although leakage of the ground was greater in the initial holes and more cement was required, the reduction of leakage was progressively accomplished with a consistent and highly satisfactory showing, further confirmed by the corresponding reduction in amount of grout required for final holes. One other bit of evidence, not entirely conclusive, was the apparent rise of the water plane, after grouting, in portions of the river bed inclosed by coffer-dam, with consequent inflow to the open trench ahead of concrete work, at points where such inflow had not previously occurred. This phenomenon might have been partially caused by other means, but apparently the sealing of passages in the bed rock by grouting was the principal cause.

The diagrams in Fig. 8 show graphically and in detail the relative position of borings, with a complete record of the drilling, testing and grouting of each hole.

The principal average results are given in Table I.

TABLE I. SHOWING AVERAGE LEAKAGE UNDER PRESSURE TEST AND AVERAGE USE OF CEMENT IN GROUTING

	Leakage of water under 127-ft. head. Gallons per minute per boring	Sacks cement used in grouting. Average per boring
Primary holes, (18) first section	33.1	10.3
Secondary holes, (17) first section	5.5	12.7
Primary holes, (10) second section	71.5	42.3
Secondary holes, (10) second section	28.3	17.6
Tertiary holes, (11) second section	11.2	4.5
2nd tertiary holes, (11) second section	6.4	3.7

Two of the downstream holes in section one, situated in the two 9-ft. diameter outlet conduits through the dam, were bored to a depth of 70 ft. and not grouted. These borings will afford future opportunity to observe

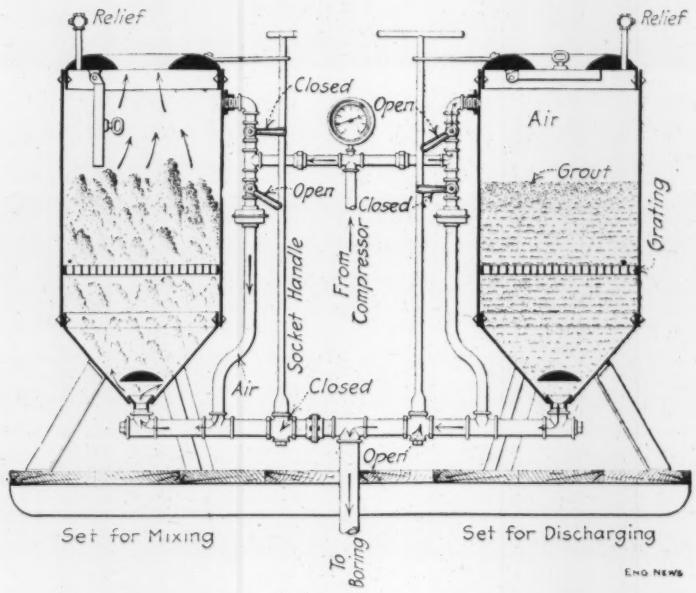

Fig. 7. Details of the Caniff Grouting Machine

the effect of filling the reservoir upon the percolation of the section of foundation which is penetrated by them.

The casings through the concrete wall where not grouted were plugged with concrete.

As elsewhere stated, the deepest boring and grouting reached 100 ft. below the natural stream bed. A number of holes reached 80 ft., and the average depth of sealed foundation strata is about 70 ft.

With the deep concrete cutoff wall extending into the more homogeneous and impervious clay banks of the abutments on both sides of the river it is confidently expected that seepage from the reservoir through the foundation of the dam will be negligible.

Fig. 1 is a map of the site showing the layout of the dam structure. It will be noted from that that the cutoff wall is not in a straight line. Fig. 2 is a view of the site looking northeast. Fig. 4 shows the drilling outfit at work, and Fig. 5 the well casings in position.

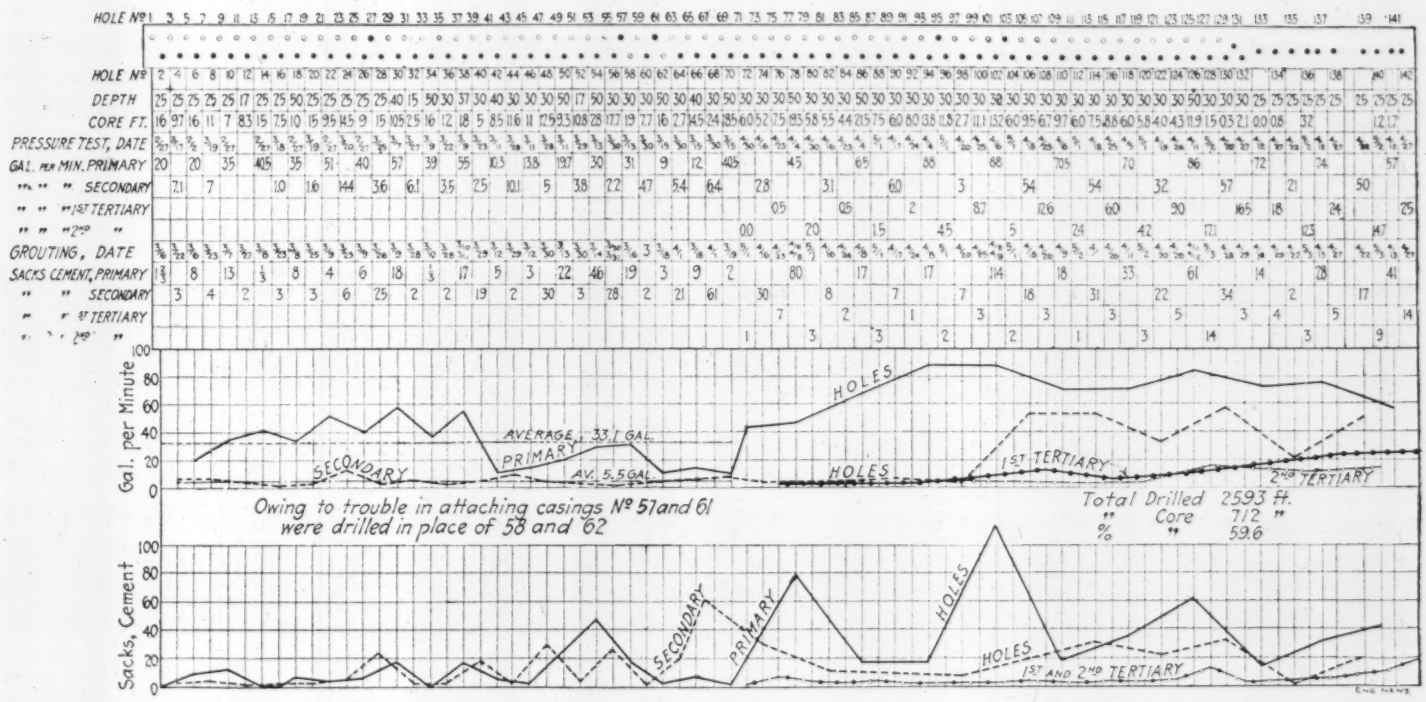

FIG. 8. LOG OF BORING AND GROUTING HOLES IN FOUNDATION OF LAHONTAN DAM

DATA ON HOLES NOT GIVEN IN TABLE

(Holes in upper row on diagram)

	9	17	27	93	103	131
Depth, ft	40	25	25	70	50	25
Core, ft	18	14	13.5	35	16	105
Date	3/31	3/32	3/31	25 ft. 1.1 gal. / 50 ft. 9.1 gal.	2.5 gal. / 11.9 gal.	13.7
Gal. per min	3.1	2.8	1.7	70 ft. 21.8 gal.	.....	....
Grouted	Not	Not	3/31	.....	.....	....
Sacks of cement	..	..	3	6	4	3

COSTS

The cost account is given in the following tabulation and in Table II:

Lin.ft. of cutoff treated	220
Number of holes drilled and grouted	83
Average depth holes drilled and grouted, ft.	32
Total depth holes drilled and grouted, ft.	2593
Total sacks cement used	1174
Total cost per ft. of hole	$3.57
Total cost per ft. of cutoff wall	42.12
Total cost of boring and grouting	9,267.17
Cost of equivalent length of cutoff by trenching and concreting, based on figures for 30 ft. trench, probably minimum of	$12,590.00
Saving by boring and grouting process	$3,322.83

TABLE II. FEATURE COSTS

Item	Cost Total	Cost Ft. of hole
Foremen	$753.77	$0.29
Making forms, placing pipe	474.94	0.18
Drilling	2397.81	0.93
Grouting	742.68	0.29
Corral expense	98.00	0.04
Supplies—fuel and oil	19.60	0.01
Supplies—lumber	75.03	0.03
Supplies—miscellaneous	192.32	0.07
Material—cement	814.45	0.31
Material—pipe	1121.38	0.43
Repairs	186.74	0.07
Power	86.83	0.03
Repair plant	138.46	0.05
Equipment depreciation	911.87	0.35
Total field cost	$8013.88	$3.08
Engineering	487.03	0.19
Superintendence	195.43	0.08
Clerical	165.45	0.06
Camp maintenance	306.54	0.12
General office expense	98.84	0.04
Aggregate cost	$9267.17	$3.57

PERSONNEL

The work was done between February and May, 1912, under the regular organization of the U. S. Reclamation Service engaged in the construction of Lahontan Dam by administration forces. Immediately in charge of details was H. S. Rands, Assistant Engineer, who had previously accomplished similar work in the foundation of the Estacada Dam, Clackamas River, Oregon, for the Portland Railway Light & Power Co.

The excellent results and the complete record of them are largely due to the expert and faithful efforts of Mr. Rands in coöperation with the Superintendent, L. G. Maney, and the Resident Engineer, F. H. Tillinghast.

❋

Corrosion of a Long Steel Pipe Line, at Port Elizabeth, South Africa, is reported in the Cape Times," of Jan. 30, as follows:

A long debate on the water-works took place at today's meet of the Port Elizabeth Town Council, when it was stated that seven million gallons of water were being lost monthly between the water-works and the town owing to a leakage in the pipes. When the new water-works were constructed some six or seven years ago the town saved many thousand pounds in the cost of transport by laying down steel mains instead of cast iron. Washouts about a year ago revealed that this steel pipe was not wearing at all well; in fact, at several points it was discovered to be completely rusted through. The defective pipes were replaced, but now it transpires that practically the whole main, over 25 miles long, is affected and will have to be replaced. The Council decided to delay action pending a detailed inspection of the main by the Board of Works.

A New Form of Cooling Tower, for use in connection with low-pressure steam turbine installations where the available supply of condensing water is limited, is being introduced by the Wheeler Condenser & Engineering Co. The tower is of wood, largely cypress, which lasts indefinitely under conditions that would rot out other varieties. No fan is used, the draft being natural. Cold air enters at the bottom of the stack, and is drawn up by the chimney effect produced by its taking heat away from the water jets. The water is admitted about half way up the stack and is distributed evenly in the horizontal plane through a system of pipes. Flowing through apertures in these pipes, the water falls through layers of wooden lathing inclined and crossed in such a way as to produce a thorough breaking up of the drops into very fine particles, resembling a thin film or spray. At the bottom of the tower the water flows into a storage tank or wells from which the condenser is supplied.

With such an arrangement as described, the temperature gradient between air and water tends to remain fairly constant since the initial contact between them at the bottom of the tower occurs with the air and water both at their coolest, while the final contact takes place at the top of the cooling bank with both air and water at their warmest point. Figures taken from 24 tests at two different plants and under varying conditions of temperature, humidity and quantity of water, show an average temperature difference between air entering and water leaving of 9+° F. and the same difference of temperature between water entering and air leaving. In the same tests the air was found to leave in each instance with 100% humidity, that is, it carried away all the water theoretically possible at the given temperature and pressure.

The Topographic Survey of Cincinnati*

By Hugh C. Mitchell†

SYNOPSIS—A description of the topographic survey of a thickly settled city, primarily for the improvement of a comprehensive sewerage system, giving the various steps, the triangulation, measurement of the base line, precise levels, transverse work and planetable work in detail.

In planning a topographic survey of a city like Cincinnati, Ohio, or of any extensive area, various questions arise which must be satisfactorily answered before the parties take the field. These questions may be stated briefly as follows: (1) On what scale is the map to be made? (2) What kind of projection is to be used in plotting? (3) To what datum plane will elevations be referred? (4) How is the relief to be shown and in what detail? (5) What artificial features are to be mapped? Dependent on these are two more questions, (1) With what degree of accuracy is the map to be made? and (2) How is it to be made? That is, what instruments and what methods are to be used?

Primarily the uses which the topographic map is to subserve determine the amount and kind of detail (relief, drainage and culture) which is to be mapped, and the accuracy with which this mapping is to be done. This being decided upon, a scale is selected on which the various desired features can be shown, and instruments and methods adopted with which the required results can be obtained.

What projection to use is another question. Its selection is governed largely by the extent of the area under consideration. Many different kinds of projection have been devised by mathematicians, but only two, besides the simple rectangular system, have been adopted to any extent by engineers: the Mercator, a projection on a tangent cylinder, and the polyconic, a projection on a series of tangent cones. For limited areas the rectangular linear projection is generally used. Its simplicity recommends it, and the ignoring of the convergence of the meridians makes it a desirable projection for use in traverse work.

The questions proposed are best answered in a general way, as follows:

Objects of the Survey—It was decided after a thorough study of the subject to produce a map which would serve not only the immediate needs of sewer planning, but would also be acceptable for general engineering use in the office of the city engineer. Such a map could be used not only for planning relief and storm sewers, or a complete sanitary sewer system and the location of disposal works, but would also serve in locating new roadways, laying out subdivisions, improving creeks for landscape and park work, for bridge work, city planning, and even for architectural work.

Scale Adopted—In order to show the desired features, relief, roads, drainage, streets, prominent and public buildings, and benchmarks, with sufficient detail and accuracy a scale of 1 in. = 400 ft. was adopted. In proportional parts this is 1 in 4800. On this scale it is possible to show the heavy relief around Cincinnati by contour lines. Even where the cliff-like slopes merge the contours into almost solid masses, the effect is to accentuate the expression of the topography. To fit the varying degrees of relief, it was decided to use a 2½-ft. contour interval on slopes of less than 6° (10%); a 5-ft. contour interval on slopes of more than 6° and under 12° (20%); and a 10-ft. contour interval on slopes of more than 12°.

Datum Plane—The datum adopted was mean sea level, the ultimate datum of all engineering work. We were fortunate in having in Cincinnati and vicinity a number of benchmarks whose elevations above mean sea level are known, having been determined by lines of precise levels run by the United States Coast and Geodetic Survey, dependent on many years of tidal observations. To show the effect of the adoption of a mean sea level datum on the horizontal projection, I will say that a line 18 miles long (Cincinnati's greatest dimension) and at an 800-ft. elevation, when projected on a mean sea-level surface is shortened 3.6 ft., or $^1/_{26000}$. On the scale adopted for the survey this amounts to less than $^1/_{100}$ in.

Putting this in another way, the engineer who uses our map is safe in measuring his traverses in the usual way and applying the results to the map without first making a sea-level reduction. If the engineer is using a 1 in. = 400 ft. sheet, the correction to sea level on a line across one sheet can never amount to more than $^1/_{1000}$ in. If he be using a 1 in. = 1200 ft. wall map, which it is hoped we will be able to publish, the longest line will receive a reduction which will plot less than $^3/_{1000}$ in.

Kind of Projection—In selecting the kind of projection to be used the polyconic projection was rejected for the slightly less accurate rectilinear coördinate system. By slightly less accurate is meant that for small areas the polyconic projection gives the most accurate representation on a plane of a system of lines measured on the ground and referred to a common datum. The laying out of a polyconic projection, however, requires a special set of tables; and where a number of projections are to be worked on and later combined into one map, as we expect to do here, these various projections must be laid out, not independently, but as parts of a single system having only one central or straight meridian. This, most assuredly, would be no small task.

Inaccuracies of a Rectilinear System of Projection—If we construct a polyconic projection on a scale 1 in. = 400 ft., a parallel of latitude 18 miles long would be represented by a curved line about 20 ft. long; the total actual curvature being 42 ft. or 0.1 in. on the map. On the rectilinear projection this same parallel would be shown as a straight line of practically the same length. Other parallels would be similarly displaced; the displacement of meridians would be much less.

These values represent the greatest divergence between two maps of the city made on the two projections on the adopted scale of 1 in. = 400 ft. Notice, however, that the divergence is one of position, not of length. The divergence in length of any line scaled from the two maps would not be as much as 10% of 42 ft., or less than 5 ft.; and on a single sheet, representing as it does an area ap-

*Based on a paper read before the Engineers' Club of Cincinnati, Nov. 21, 1912.

†Engineer in charge of topographic survey, Cincinnati, Ohio; formerly Assistant and Computer, U. S. Coast and Geodetic Survey, Washington, D. C.

proximately 1½ by 2 miles, the two projections practically agree, their greatest divergence amounting to 0.5 ft. or only 1/806 in. by scale.

The advantages of the rectilinear coördinate system are the simplicity of construction and the use of a single meridian for all traverse work, thus avoiding the use of tables for convergence of meridians, and greatly simplifying the computations.

METHODS AND INSTRUMENTS—The survey work may be divided into three groups: (1) precise control, (2) primary control and (3) topographic work.

(1) The precise control consists of the triangulation and the precise levels.

(2) The primary control comprises the measured traverses and elevations determined with wye levels. It is the connecting link between the precise control and the topographic mapping.

(3) The topographic work consists of the making of the map itself—the delineation on paper of the various artificial and natural features required to be shown.

THE TRIANGULATION—The triangulation scheme consists of primary stations, secondary stations, and intersection or tertiary stations. The lengths of this triangulation are controlled by two base lines. One is a line of the great arc of triangulation which extends across the United States approximately along the 39th parallel of latitude. Not only does this line (the southern line of our scheme), which lies in Kentucky some 8 or 10 miles south of Cincinnati, control the lengths in our triangulation, but it fixes the position and orientation of that triangulation on the spheroid. In other words the geodetic latitudes, longitudes and azimuths of this line furnish the data for computing the geographic positions of all points of our triangulation, and the true azimuths of all our lines. This will make our triangulation a part of the great system of triangulation which comprehends practically the entire country. From our triangulation station on the Hughes high school we can go by unbroken chains of triangulation to the Straits of Juan de Fuca, to Key West, Fla., to Calais, Me., or to San Diego, Calif.

The other line which controls the triangulation lengths (and lengths only) is a measured line (Fig. 1), measured along Clifton Ave. and referred to the line connecting the two triangulation signals on the Hughes high school and the Clifton school.

BASE-LINE MEASUREMENT—This base was measured with apparatus generously loaned to the city of Cincinnati by the U. S. Coast and Geodetic Survey and consisting of three invar tapes, each 50 m. in length, with tape stretching apparatus and thermometers. These tapes have a coefficient of expansion per degree Centigrade of 0.0000004 as compared with 0.000011 for steel tapes. In measuring, these tapes were supported at both ends and middle, the middle point being on grade between the end points. The ends of the tape were held to fine lines on copper strips nailed on 3x4-in. posts set firmly in the ground. In measuring the base line an innovation in such work was introduced by breaking the line actually measured by right-angle offsets. This was necessitated by a jog in the line of the street and in order to have the measurement made along the lawn bordering the street, instead of in the middle of the street. The Clifton Ave. base line is 2395.8665 m. long, with a probable error of 6.5 mm., which represents 1 part in 400,000. This is a rather large probable error for a measure of this kind, but it was expected because of difficulties encountered in measuring along a much traveled thoroughfare like Clifton Ave.

The base line as measured was referred by measured angles to the line of the triangulation connecting the signals on the Hughes high school and Clifton school (see Fig. 2). In carrying this length through the triangulation to the line Stevens-Tanner of the Coast and Geodetic Survey triangulation the discrepancy developed, as determined by the least square computation, was 1 part in 55,000.

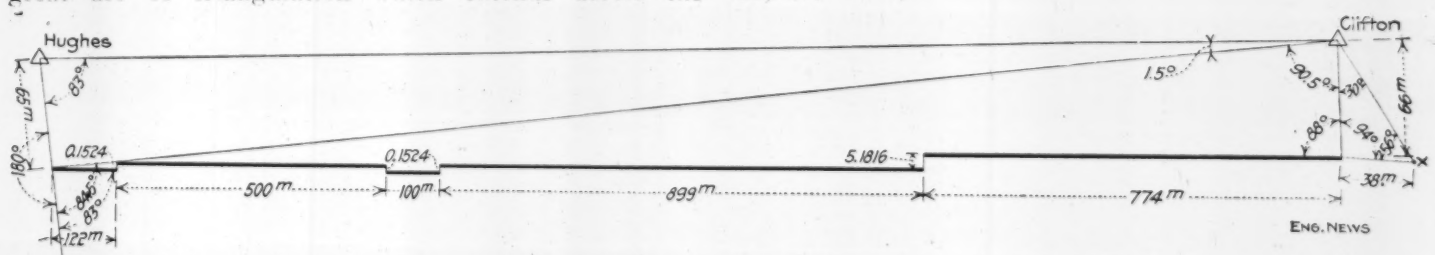

FIG. 1. DIAGRAM SHOWING MEASURED AND COMPUTED BASE LINE, CINCINNATI TRIANGULATION

(The two small right-angle offsets were necessary in order to avoid electric railway poles; the large one was due to a jog in the line of the street)

ANGLE MEASUREMENTS—The angles of the triangulation net were measured either with a 12-in. direction theodolite or with a 10-in. Gambey repeating theodolite. The direction theodolite was used on signals such as Eden Park water tower, Hughes high school, and on especially constructed towers which rested on the ground. The repeating instrument was used on the more unstable signals such as the towers which rested directly on the roofs of the Madisonville, Westwood and Warsaw public schools.

In using the 12-in. theodolite the directions of the various signals observed were referred to some one signal as an initial. The primary directions were observed with telescope direct and reversed, and for the horizontal circle in each of 16 positions. The tertiary signals were observed from each of two positions of the circle. The direction instrument has no vernier, but its circle carrying 5′ graduations is read by means of three micrometer microscopes to single seconds. A primary station like the Hughes high school, from which 13 primary directions radiate, necessitated 2500 micrometer readings on the primaries alone.

In using the repeating instrument the angles between adjacent stations were measured, the angle to close the horizon being always measured. Each angle was measured with six repetitions on the angle itself with telescope in position direct and followed immediately with six

repetitions on the explement with telescope reversed. Each six repetitions constitute a "set," and 10 such sets of measures were made on each angle, five on the angle and five on its explement. Any set giving a residual of more than 4" from the mean was rejected and a new measure made to replace it. In the direction instrument work the limit of rejection was 5".

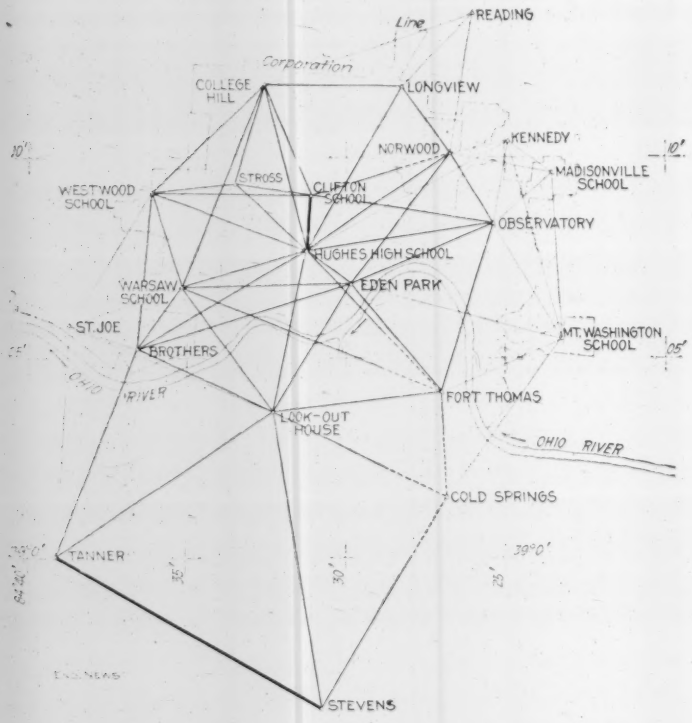

FIG. 2. TRIANGULATION NET OF CINCINNATI TOPOGRAPHIC SURVEY

The tertiary signals of the triangulation net consist of objects such as steeples, cupolas, chimneys and stacks. Their positions were determined to help control the topography. The average closure for all the triangles of the net was 2.61". In all, the triangulation fixed the geographic position of 17 primary stations, 2 secondary stations and about 50 tertiary stations.

PRECISE LEVELS—The precise-level instrument and rods used in this survey were loaned the city of Cincinnati by the Coast and Geodetic Survey. The instrument used is a type devised in the instrument shop of the Coast and Geodetic Survey, and is steadily coming into favor with the geodetic surveys of foreign governments, and with municipal engineers.* This instrument is irreversible and as simple as possible. The telescope is mounted on trunnions between its center and objective, while its eye-end is supported on the point of a micrometer screw. The level phial is countersunk into the barrel of the telescope and is fixed except for a small range of motion required for its adjustment. By the use of nickel iron having a low coefficient of expansion for the casting of this instrument, the effect of temperature has been practically eliminated.

The rods used with this instrument are self-reading, single sticks of cross-shaped section, and have been rendered impervious to weather conditions by boiling in paraffin. The shoe of the rod is cylindrical, with a rounded or hemispherical-shaped bottom. Such a shoe requires a plane or a cup-shaped surface for a turning point. Speaking of turning points, let me say that the use of street-car rails as turning points has been thoroughly tested and found to be most satisfactory. In the precise-level work done by the U. S. government, rails are used almost exclusively for turning points.

Two rods were used, but only a single line was run at one time. Each section between benchmarks was leveled over backward and forward. The two measures are usually made under different conditions, that is at different times of day, and the like. The limit, which, when exceeded, demanded a rerunning of a section between benchmarks is an agreement between the backward and forward runnings over that section of 4 mm. $\sqrt{K}$ or 0.017 ft. $\sqrt{M}$, in which K or M represents the length of the section in kilometers or miles.

In planning the precise-level work reference was had not only to the needs of the topographic survey, but also to the future needs of the city's engineering department. In all 217 benchmarks have been set in and around Cincinnati.

BENCHMARKS—These benchmarks consist of either bronze caps or discs, bearing the legend: "City of Cincinnati, Topographic Survey of 1912, Bench Mark No. ——" (see Fig. 3). The discs have a corrugated tenon extending from their under side, which is cemented into solid and permanent masonry structures. In a few cases a column of concrete was made and the discs set in top of same. The caps are screwed on top of iron pipes, which are split and spread at the bottom and are filled with concrete and set in concrete.

These benchmarks are, as a rule, set in pairs, and are given such geographic distribution as will place at least one pair of benchmarks in each square mile of territory. In placing the benchmarks in pairs it was aimed to insure against the use of a benchmark which had undergone

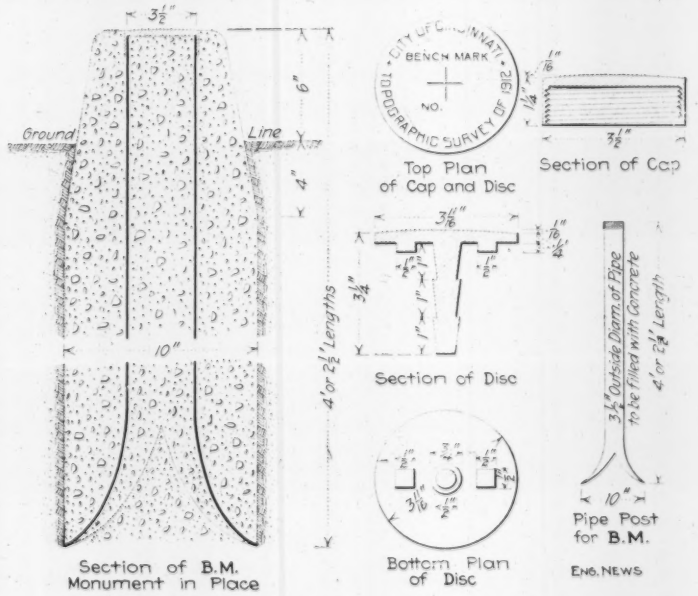

FIG. 3. STANDARD BENCHMARK, CINCINNATI CITY TOPOGRAPHIC SURVEY

any change in elevation. It was intended that the engineer should start from a pair, and if he finds the two benches of a pair unchanged in their relation to each other he is reasonably safe in assuming the elevation of the benches correct. The two benches of a pair, while usually placed about one block apart, are sometimes several blocks apart.

*A complete description by Mr. Mitchell of this level may be found in Eng. News, Mar. 23, 1911, p. 356.

A few of the closing errors of the precise-level circuits may prove interesting. The first circuit—from Winton Place through Norwood to Madisonville, down through Hyde Park and Walnut Hills to the Court House, thence through Clifton to Winton Place—failed to close by 17 mm., or ⅔ in. The length of the circuit was 45 km., or 28 miles. The circuit from the Court House over Eastern and Delta Aves. to Erie Ave. closed on a portion of the line just referred to with an error of 13 mm., or ½ in. The length of the entire circuit was 27 km., or 17 miles A line out Reading and Paddock Roads from Florence Road to Ross Avenue failed to close by 15 mm., or 0.6 in., on the circuit through Madisonville. The length of

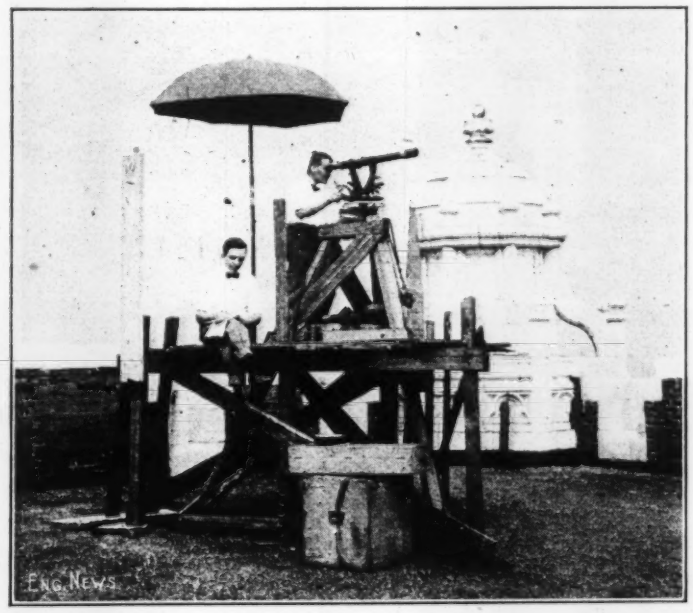

FIG. 4. TRIANGULATION STATION ON THE HUGHES HIGH SCHOOL; TRIPOD RESTS ON CONCRETE FLOOR BELOW THROUGH HOLES IN ROOF

the entire circuit was 31 km., or 19 miles. A line up Mill Creek Valley between permanent benchmarks of the Coast and Geodetic Survey failed to close 12 mm., or ½ in. The line was 9.5 km., or 6 miles, in length.

TRAVERSE—The connecting link between the precise control and the actual mapping of the topography is the traverse work or, to more definitely distinguish it, the principal traverse. This consists of a network of measured lines fixing the horizontal positions of a large number of stations which are well marked on the ground. These lines were nearly all measured with a 150-ft. steel tape, deflection angles being measured with a Berger engineers' transit, reading to minutes. This network of traverse lines will, in a certain measure, be adjusted to the triangulation. Over these various traverse lines are run lines of wye levels which are connected with precise-level benchmarks, and in this manner a sea-level elevation is obtained on each traverse station. The traverse lines were run in closed circuits, the average closing error being 0.37 ft. per 1000 ft., or 1 part in 3000. The average closing error on the wye-level lines amounted to 0.031 ft. per mile.

TOPOGRAPHY—After considerable study of instruments and methods the planetable was adopted as best suited for this part of the work. It may be interesting to mention some of the arguments for and against the planetable as compared with the transit. The principal arguments for the transit are the greater number of engineers available who are familiar with such work; the greater progress in the field, due to carrying a good portion of the work into the office, and, perhaps the greatest consideration of all, the fact that when the map is completed the transits secured for the work can be utilized for other purposes.

Against the taking of topography with the transit is the one very important reason, the possibility of blunders in the observations creeping undetected into the map; and the smaller consideration, the unnatural appearance or stiffness of the resulting map. Against the use of the planetable are two arguments: the difficulty of securing men trained in such work, and the fact that the completion of the map would leave the city in possession of a number of planetables, instruments practically useless for other work. Balancing these arguments were the facts that with the planetable a good topographer secures an accurate and a true expression of the topographic forms, and that blunders such as do sometimes occur in transit work can not occur in planetable work where reasonable care is taken.

METHODS—Each topographer is furnished the smooth sheet on which the control, that is the traverse stations, is plotted to scale. This he fastens to his planetable board with thumb screws. He is also given a data sheet—a blueprint on which is shown on the same scale as his smooth sheet all the traverse work on which the topography plotted on the smooth sheet is based. On the blueprint are given all data which the topographer requires, consisting of descriptions and elevations of all stations. Referring to this blueprint the topographer identifies the stations marked on the ground, and orients his table. In certain portions of the map where tests show that there is no local magnetic attraction and also where

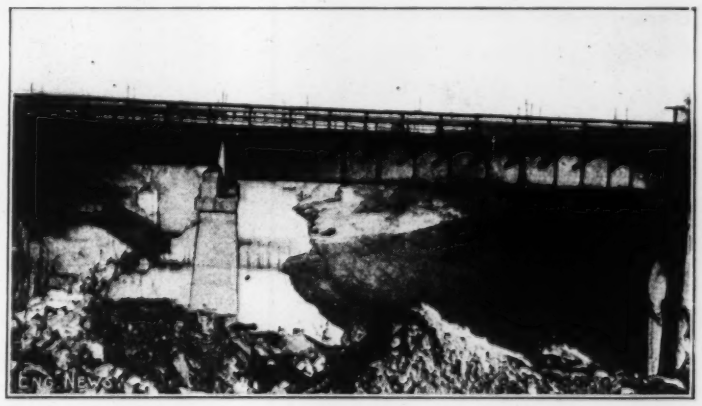

FIG. 5. EXAMPLE OF CINCINNATI TOPOGRAPHY; MILE CREEK, A PRESENT SEWER EFFLUENT

thick brush and high weeds render orientation by back-sighting impracticable, the magnetic needle is used for placing the table in orientation.

Each topographer works in circuits, which he always closes. His closing error is the index of his work, and we demand that it shall not exceed 5 ft. or one division of the plotting scale. Some of these circuits are really traverses with the planetable between points fixed by the principal traverse and more than 3000 ft. apart. Our demand for a closure that is practically exact is always met. These closures are quickly and easily checked in the field by an inspector. A random line cross-sectioning any part of planetable traverse also gives an excellent

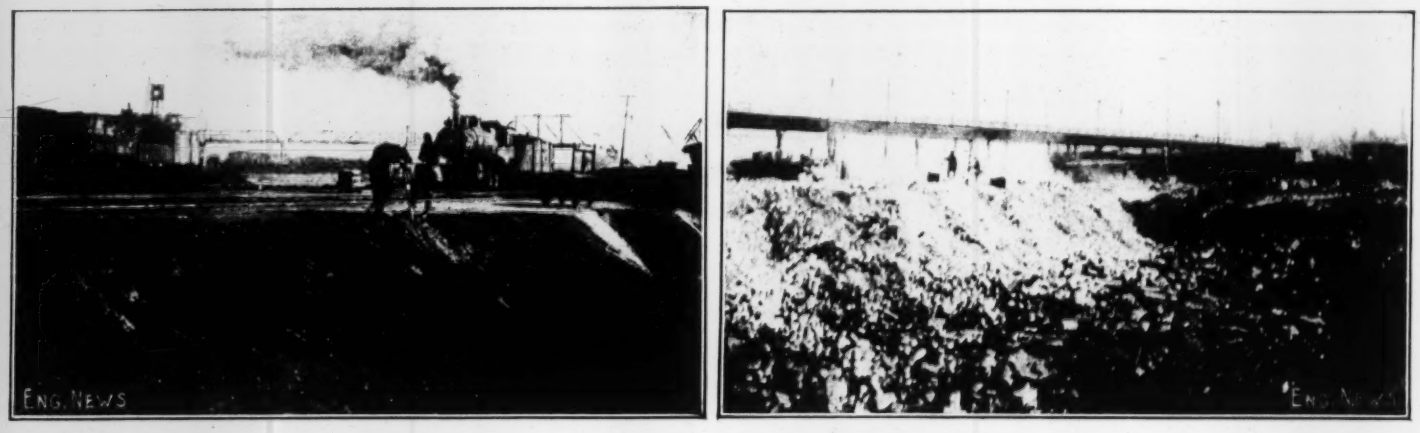

FIG. 6. PLANETABLE WORK UNDER DIFFICULTIES; TOPOGRAPHIC SURVEY OF CINCINNATI

check on the general accuracy of the planetable work and would show at once any "fudging" of traverse lines.

The greatest obstacle which has been encountered in holding the high degree of accuracy which has been adopted as standard is the unstable character of the paper used for the planetable maps. Ordinarily paper which is to be used for work of this kind should have at least two years of seasoning. Such paper could not be secured for this survey, but the best paper available was obtained. Some of it, however, was in the field within less than a month after it was mounted. As a result some of the paper shows an extreme change of 7 or 8 ft. per 1000 between a dry day and a humid one. The sheets consist of two pieces of super-super paper mounted with grains at right angles with muslin between. The sheets are 24x31 in. in size, the map area being 20x27½ in., representing an area on the ground 8000x11,000 ft., or 3.16 sq.m. The accuracy of the planetable work which is being done on the map of Cincinnati is such that the shrinkage of the paper used swallows up all errors of observation and plotting.

This planetable work is done by contract, which was entered into only after it was determined that experienced men in this line of work were not otherwise available. The firm of Brown & Clarkson, topographic engineers of Washington, D. C., is doing this work, and the city of Cincinnati is fortunate in having secured the services of men who bring so much ability, experience and integrity to their work as will insure the city a topographic map comparable in many ways with the maps of the cities of Washington and Baltimore. The cost of the Cincinnati map will be less than one-fourth that of the Baltimore or Washington maps.

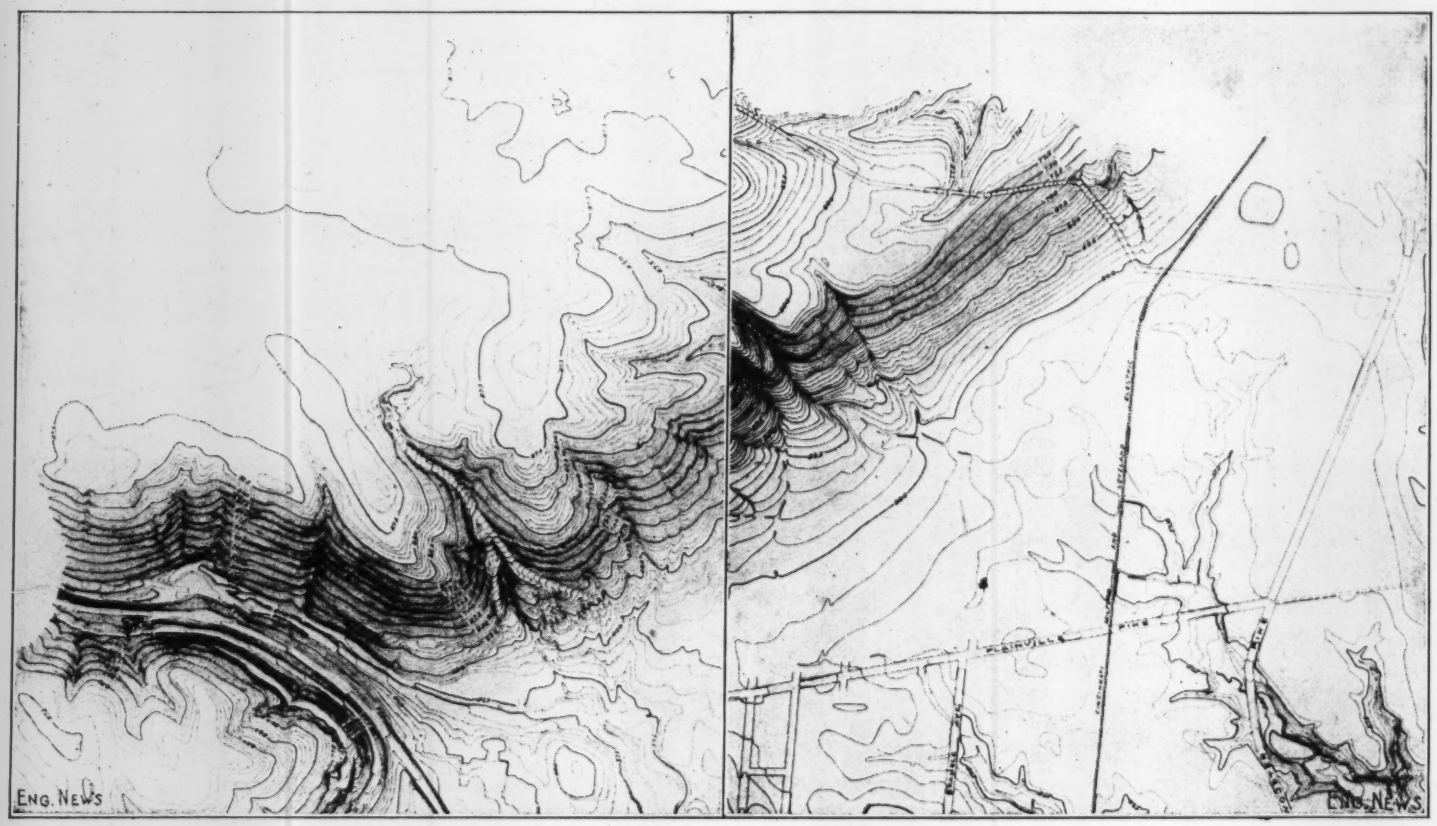

FIG. 7. SAMPLES OF CINCINNATI TOPOGRAPHY: PHOTOGRAPHS OF PLANETABLE SHEETS

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Electric Traction is to replace steam, for suburban traffic, on the main line of the Pennsylvania R.R., between Philadelphia and Paoli, Penn., a distance of some 20 miles, according to an announcement of the directors on Mar. 13. It is expected that the cost will amount to $4,000,000.

A Great Steam-Electric Power Plant*

By W. L. Abbott†

SYNOPSIS—The electric-generating plants of the Commonwealth Edison Co., at Chicago, have presented many special features of interest in novelty and size of the equipment, and among the most recent developments is the planning of an immense station of 240,000 kw. capacity, with turbo-generator units of 20,000 kw. each. The first two units are now in operation and are notable as being the largest ever built. The following article descriptive of this new power station is of interest in that it outlines some of the features governing the location and design of the station, besides giving a description of the complete plant (as proposed) and its initial installation. We call particular attention to the last portion of the article, which shows that owing to the rapid development of machinery of this kind, the present units (although of such recent date) will soon be eclipsed by others, and that the future units probably will be of an entirely different type from those now in service.

The dominant factors in determining the selection of a power site are those involving the economical handling and utilization of coal. As the cost of fuel greatly exceeds all other operating costs combined, and as the consumption of fuel when running condensing and non-condensing is in the ratio of 2 to 3, it appears that unless the coal consumption is to be increased 50% the power house must be accessible to an abundant supply of condensing water. This then is the first consideration for a power-house location.

If we assume $1.70 per ton as the average price of coal in Chicago, and 60c. a ton as the minimum cost of cartage from a railway to the power house, it appears that unless the cost of fuel is to be increased 25% the power house must be located adjacent to a railway and preferably on the road which brings the coal to the city. Therefore, the determining factor of second importance is railway facilities.

SELECTION OF SITE

Desirable power-house sites are hard to find, so when a satisfactory location is found it is advisable to provide for a good-sized installation, which will take care of all increases in the load for a considerable period, say five years. At the time the Northwest Station was to have been started (winter of 1911-12) the maximum load on the company's system was about 200,000 kw., and the indications were that for a number of years the increase would average 15% a year, which indicated that the net increase of load during the following five-year period would amount to about 220,000 kw. Accordingly, acreage sufficient to accommodate two power houses of 120,000 kw. each was sought. It was not the intention to install this amount of power all at one time, nor even during the five years mentioned, as existing power houses could still be added to and other new power houses might be commenced. But it was considered that a site which might be built up at will and eventually accommodate 240,000 kw. would not be at all too large.

What acreage is required to accommodate a 240,000 kw. power house? Experience has shown that a power house supplying a diversified metropolitan load will at some seasons of the year run at a load factor of 50% of the installed capacity. For a 240,000-kw. installation this will require a daily coal supply of something over 4000 tons, or about 100 car-loads. To make a moderate allowance for the uncertainties of freight traffic over a distance of 200 miles, provision should be made for storing on the property at least three days' supply of loaded and one day's output of empty cars, amounting altogether to 400 cars, which will require four miles of storage tracks. The Chicago market is subject to an interruption of its coal supply every two years, pending a discussion of the wage scale, such interruptions lasting sometimes as long as three months. Therefore, a public service company of our kind should have facilities and room to store at least 90 days' supply of coal, which for the power house under consideration would be about 350,000 tons.

The power house, storage tracks, storage pile, and switch tracks will require about 50 acres, but after allowing for convenient spacing, parking and recreation grounds it will be found that the total space required for such a plant is not less than 75 acres, the greater part of which is for receiving, storing and handling coal.

On the west side of the north branch of the Chicago River, and north of Roscoe St., was found a 55-acre tract, the remains of the old Bickerdike farm. The Chicago & Northwestern Ry. is nearly a mile from the river, but the intervening space is occupied by the Bickerdike tract, two blocks of dwelling houses and a 40-acre truck garden. This situation at once suggested that the two pieces of property be bought, and also right-of-way for a private railway connecting with C. & N. W. Ry. and crossing the residence blocks, which are built up with cottages and two-story dwelling houses.

GENERAL DESIGN OF POWER STATION

An aggregate of 240,000 kw., or 350,000 hp., in one building would create possibilities for an interruption to the entire supply. It was deemed prudent, therefore, to divide this capacity between two separate power houses of equal size.

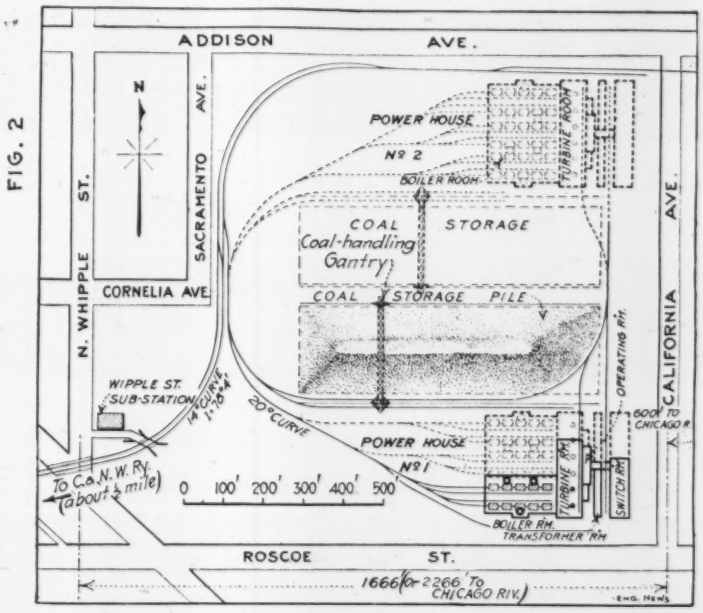

FIG. 2

FIG. 1. PLAN OF PROJECTED NORTHWEST GENERATING STATION OF 240,000 KW. CAPACITY, AND ITS INITIAL INSTALLATION; COMMONWEALTH EDISON CO., CHICAGO

Since the purchase of the land, California Ave. has been opened, cutting the site in two. But this probability had been foreseen, and the station's coal pile and trackage were located west of this avenue.

Fig. 1 is a general plan, showing the two power houses, facing on California Ave. and symmetrically arranged on either side of a central east and west axis. Each has its system of railway tracks and has a large storage field spanned by a gantry crane 265 ft. long.

Each of the two buildings consists essentially of a turbine room 70x290 ft., and 55 ft. high, on one side of which is the boiler room. The boilers are arranged in rows of ten, one row opposite each turbine and with a smokestack to each row. Each building is designed for six turbines and 60 boilers, as shown. The transformer house and the switch house are in separate though connected buildings. About 66% of the first building group has been completed, although only 33% of the equipment has been installed.

The coal railway to the C. & N. W. Ry is a double-track line, elevated so as to cross all streets by bridges, and the city ordinance under which the company built this line in a residence district required that electricity must be used for the motive power. The company has purchased two 60-ton electric locomotives (each with four motors of 200 hp.), and

*Abstract of a paper on "The Northwest Power Station of the Commonwealth Edison Co.," read before the Western Society of Engineers, Chicago, Dec. 22, 1912.

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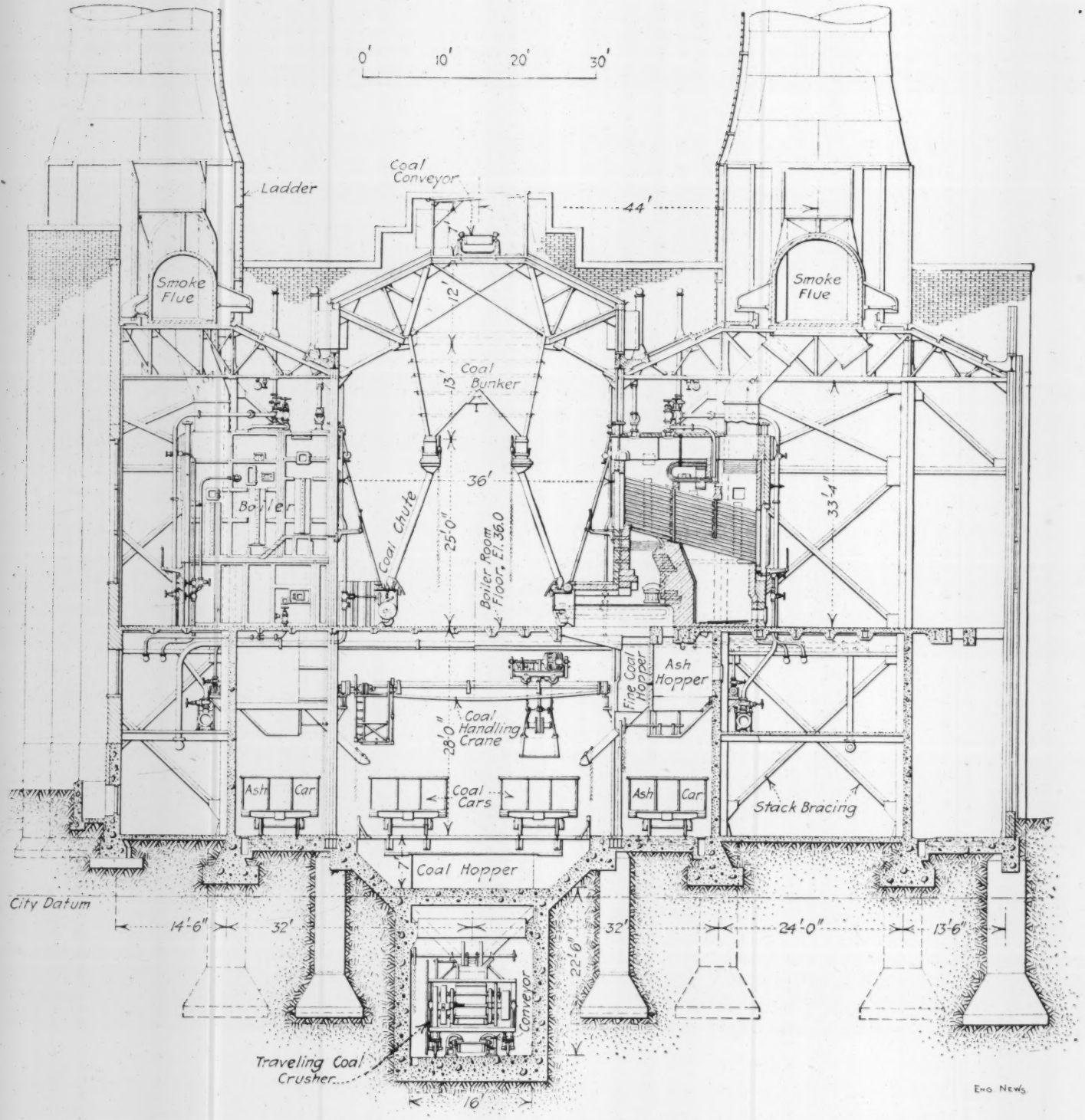

FIG. 2. CROSS-SECTION OF BOILER HOUSE AT THE NORTHWEST POWER STATION; COMMONWEALTH EDISON CO., CHICAGO

has already equipped three miles of track with a third-rail conductor. It is recognized, however, that in a switch yard an overhead supply of power may be preferable, and for this reason each locomotive is equipped with a pantagraph trolley.

CONDENSING WATER

The water for condensing is drawn from the river through a double-deck tunnel, the upper conduit being used for the outflow, which is discharged into the river at a point several hundred feet down stream from the intake. In dry weather the natural flow of the north branch is relatively insignificant. The greater part of the flow is pumped from the lake into the North Channel of the Chicago Drainage Canal at Wilmette, and a smaller quantity is pumped from the lake through the Lawrence Ave. conduit.

The Wilmette pumps are electrically operated, and should this power be interrupted and the pumps stopped when the station is carrying a full load, the flow of the river would not be equal to the amount pumped for the condensers. It would, therefore, be necessary to pump a portion of the discharge around and through the condensers a second time, at a higher temperature and with some impairment of the vacuum. If the Wilmette pumps and the Lawrence Ave pumps were stopped at the same time, the river water in a few hours would become too hot to be of use for condensing. To minimize as far as possible the embarrassment which would result in the improbable coincidence of a long shutdown of both the pumping plants during dry weather and at time of full load on the station, the intake tunnel is made to draw its water from the bottom of the river at a point some distance up stream from the warm water discharge, thus using for a time the river as a storage reservoir and a cooling pond.

BOILER PLANT

The coal supply system and coal and ash handling arrangements are shown in Fig. 2. Cars containing coal are

run onto tracks over the receiving hoppers under the boiler room. There the coal is dumped into the first receiving hoppers and from there it passes through the coal crusher and into the conveyor, which elevates it to the second receiving hopper above the firing floor in the boiler room. From this hopper it is drawn by gravity, as required, to the stokers in front of the boilers. If the coal cars have drop bottoms, the unloading is quickly done by opening the drops. If a car does not have a drop bottom, it is unloaded at a cost of 2c. a ton by a 2-yd. clam-shell bucket operated from an overhead crane.

In its passage through the boiler house the coal is handled on five different levels and in nine operations, as follows: 1, delivered on the unloading track; 2, dumped into first receiving hopper; 3, run through crusher, 4, discharged into conveyor; 5, elevated to second receiving hopper; 6, drawn off to stokers; 7, dumped from back end of chain grate to ash hopper; 8, discharged into empty coal cars; 9, hauled away. The boiler house is so designed and equipped that at no point in the handling of the great volume of coal is it necessary to use manual labor.

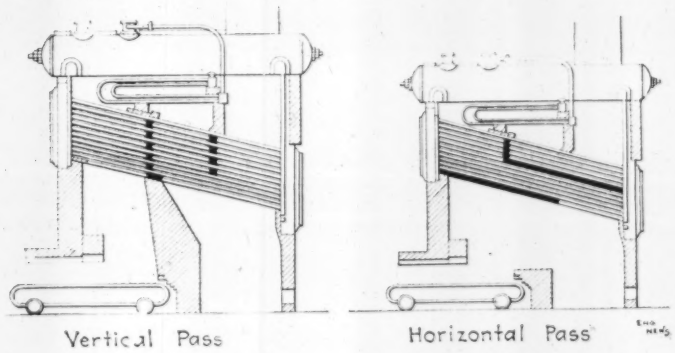

FIG. 3. ALTERNATIVE ARRANGEMENT OF BOILERS WITH VERTICAL AND HORIZONTAL PASS FOR THE GASES

The boilers are arranged in rows of ten each, facing each other on opposite sides of a common firing room, so that one set of firemen and water tenders can look after 20 boilers. Each ten boilers is served by a tile-lined steel stack 17 ft. inside diameter and extending 275 ft. above the boiler room floor.

In designing the boiler furnaces it was recognized that they must burn the smokiest kind of soft coal screenings practically without smoke. The fundamental principle in smokeless furnace design is to provide a chamber of high temperature and of sufficient length or volume to insure complete combustion of the luminous flame before it comes in contact with the boiler tubes. This can be done perfectly in a furnace having a tile roof, but unfortunately two other things, both undesirable, are also accomplished. The changed gas passage restricts the draft and reduces the boiler capacity, and at the same time the furnace temperature is so high that the expense of maintaining furnace walls and arches is greatly increased.

In the design used at the Northwest Station the boilers were set with the high end of the sloping tubes to the front and 10 ft. above the grate, this great height serving as a vertical combustion chamber, with ample capacity to give the flame time to burn out before it reached the tubes. The draft would not be restricted and the brick work would be conserved by the temperature being kept down through the absorption of radiant heat by the exposed tubes. The second battery was set like the first (except that they were given a horizontal gas pass, the purpose being to give the two designs thorough comparative tests and adopt that which proved to be best. The two arrangements are shown in Fig. 3.

Each boiler should be able to easily generate 30,000 lb. of steam an hour, or 70% more than normal rating, and this rate of steaming will require a rate of coal burning of 4500 lb. an hour under each boiler, or 75 lb. a minute. This means that in each second of time 300 cu.ft. of air passes through the grate and in the heat of the furnace becomes 1500 cu.ft. With 60 boilers all running at the maximum rate, the amount of air entering the grates each minute is over 1,000,000 cu.ft. If this were all drawn through the boiler room on a winter day, the firemen would be obliged to go out of doors to get warm; but provision is made to admit air directly under the grates from the train-shed below.

These boilers have each 5800 sq.ft. of water heating surface and 350 ft. of steam superheating surface, and are equipped with traveling chain grates of 115 sq.ft. area. Steam is raised to a pressure of 250 lb. and is superheated 125°. The steam is taken from the boilers through 6-in. pipes connected with a 16-in. header supported on roller bearings in the header room. Connecting the steam headers is an 8-in. crossover, by means of which steam from one unit may be supplemented with steam drawn from an adjoining unit. The safety valves blow off through vertical exhaust pipes leading to the roof, thus eliminating the danger and discomfort of steam at high pressure discharging into the boiler room.

Each battery of boilers is provided with two 5-in. three-stage centrifugal boiler-feed pumps driven by Curtis steam turbines at 2300 r.p.m., and having a capacity of 700 gal. per min. against a pressure of 285 lb. The feed-water is pumped from the condenser at a temperature of about 75° into a closed feed-water heater of 4000 sq.ft. heating surface, in which it is heated by exhaust steam from the auxiliaries. A float valve at the top of the heater regulates the admission of make-up water into the condenser.

TURBINES AND GENERATORS

The 290 ft. length of the turbine room permits a spacing of 44 ft. for the generator units, and as the maximum outside diameter of the turbines is 15 ft., there is ample floor space for the auxiliaries. This room is spanned by a 110-ton traveling crane. The turbines are of the Curtis vertical-shaft type, rated at 20,000 kw. capacity and running at 750 r.p.m. One of these great units is shown in Fig. 4. They are six-stage, each wheel having two rows of buckets built in sections and riveted to the disk which forms the central part of the bucket wheel. The outside diameter of the sixth wheel is 13 ft. 2 in. and the peripheral velocity is over 500 ft. per sec., or about 6 m. per min. The guaranteed steam consumption, with steam at 250 lb. pressure and 100° superheat, is 14 lb. per kw.-hr. at loads of 10,000 and 20,000 kw. and 13.45 lb. at a load of 15,000 kw.

The weight of the steam end is 200 tons and of the generator 230 tons, making a total of 430 tons, of which 100 tons is in the revolving elements. This great weight is supported on the step bearing, the two halves of which are kept from direct contact by oil which is forced into the bearing at a pressure of 800 lb. per sq.in., to which the pump pressure of 1200 lb. is baffled down. Floating on this oil system is an accumulator weighted to 30 tons. Should the accumulator sink to a predetermined level, owing to failure of the steam pump, it would automatically put into operation an auxiliary electrically driven pump.

The condenser, on which the turbine rests is designed to condense 280,000 lb. of steam per hour, using for each pound of steam condensed 75 lb. of cooling water, whose temperature will be raised 14° F. in passing through the condenser. The condenser contains 7600 tubes 1 in. diameter and 17 ft. long, comprising 32,000 sq.ft. of cooling surface as compared with 58,000 sq.ft. of water heating surface in the boilers. A 20x30-in. Corliss engine, running at 120 r.p.m., drives the circulating-water and dry-vacuum pumps. The former is a 36-in. volute of a capacity of 40,000 gal. per min. against a head of 20 ft. The condenser, with its inlet and discharge pipes, forms a closed syphon, so that after the system is once filled with water the lift in one leg is balanced by the fall in the other, and the circulating pump has only to overcome the friction and inertia to circulate the water.

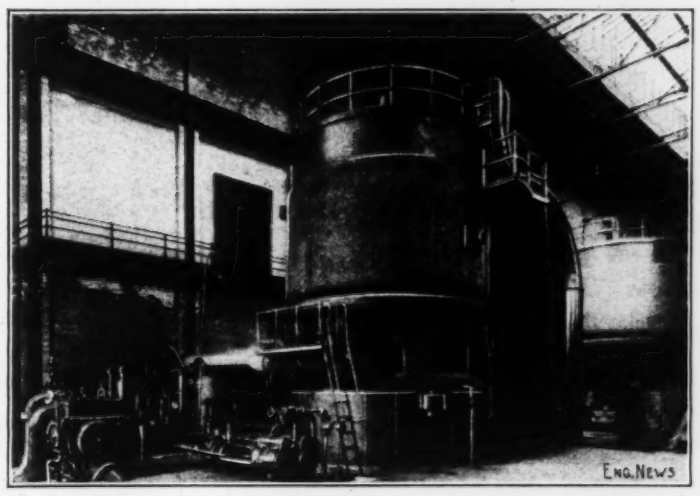

FIG. 4. TWO TURBO-GENERATOR UNITS OF 20,000 KW. CAPACITY IN THE NORTHWEST POWER STATION OF THE COMMONWEALTH EDISON CO., CHICAGO

The cylinder of the dry vacuum pump is 28x30 in., mounted in tandem with the steam cylinder of the Corliss engine, and at the speed mentioned has a displacement of 2550 cu.ft. per min. Water of condensation is removed from the condenser by a 5-in. horizontal two-stage centrifugal turbine-driven pump with a capacity of 660 gal. per min.

The generator mounted above the turbine is of the revolving-field type and generates 25-cycle, 3-phase current at a pressure of 4500 volts, which is stepped up by transformers to 9000 volts. The revolving field has four poles and weighs 52 tons. The armature is star wound and has a continuous rated capacity of 2570 amperes per phase. For the barrel-shaped armature in which the field revolves, forced ventilation is created by a fan mounted on the main shaft above the generator. The efficiency of the generator is very high (96%), and yet because of the great amount of energy transformed in the generator, the heat evolved is equal to that resulting from the perfect combustion each hour of 270 lb. of coal. The air for the forced ventilation is drawn from outside of the building.

For excitation purposes 75 kw. at 125 volts is required. In the completed station there will be four exciters. Two of these will be of 300 kw. capacity each, driven by a two-stage horizontal Curtis steam turbine running at 1500 r.p.m. and generating current at 125 volts. The other two, of 200 kw. capacity each, will be driven by 3-phase, 25-cycle, 220-volt motors running at 750 r.p.m. In addition, there will be two storage batteries of 70 cells each, with a capacity of 1000 amp.-hr.

The operating gallery is located in a bay projecting into the turbine room, and from here the operator has a clear view of the entire turbine room floor.

TRANSFORMERS AND OTHER APPARATUS

With the advent of the high-speed turbine it was found possible to build a generator whose reactance was only one-fourth or one-fifth of that of the slower speed generators. This was thought to be a highly desirable improvement and the utmost advantage was taken of the new design to keep the reactance as low as possible; but when such generators of large sizes were built and connected to a common set of busbars, it was found that nearly the whole energy stored in the high-speed revolving masses would be instantly hurled into any near-by short circuit which occurred, the energy output of the machines for the moment being perhaps 20 times the normal. Such violent surges were so destructive to generators, switches, busbars, lines and connected apparatus that it was found necessary to restore to the circuit nearly as much reactance as had been gladly eliminated. In the machines of the Fisk St. station this was accomplished by installing in each of the three armature leads to the busbar a 6% reactance—that is, a coil of wire supported on a concrete and wood frame, whose choking effect, together with the 2% reactance in the generator, at full load of the generator, is equal to 8% of the voltage generated. This effect, which is unobjectionable at normal loads, increases with the square of the current flowing and, therefore, in times of trouble affords protection which is ample and at the same time automatic. In fact, one of the Fisk St. 12,000 kw. generators was repeatedly, short circuited through a set of these reactances without harm to generator or coil.

At the Northwest Station the additional reactance needed was introduced into the circuit in the auto-transformers, which step up the pressure from the machine voltage of 4500 to the system voltage of 9000. These transformers are installed in a separate building, between the turbine room and the switch house. Each transformer is installed in a separate fireproof compartment and is of 3333 k.v.a. capacity. They are water- and oil-cooled, and contain 1700 gal. of oil. Water is circulated through pipes immersed in the oil, at a rate of 16½ gal. per min. Each tank has an emergency drain, by means of which it can be emptied of oil in a very short time. The efficiency of these transformers is very high, being 99.4% at half load and 99.3% at full load. They are 13 ft. high, 9 ft. long and 5 ft. wide, and weigh (with oil) 25 tons.

To the east of the transformer house is the switch house, a three-story building containing all the oil switches, high-tension busbars, and instrument transformers. On the first floor the busbars, cables, bells and generator leads are installed. The second floor contains the oil switches, the pots of which are built in a single row instead of a double row. This arrangement provides greater safety, in that each oil pot is separated from the adjoining one by a concrete partition. There are 19 switches for each unit: Nine line switches, eight bus and tie switches, and two generator switches.

FUTURE EXTENSIONS

The station was designed for six units, two of which were to be included in the first installation and the remaining four to follow soon thereafter, so that the station when completed would contain a symmetrical, uptodate equipment of the largest size and highest efficiency. But—alas for the best laid plans of men—between the dates that the plans were finished and the station was put in service, as great strides were made in the art as had been made during any period of equal length in its history. The Northwest Station is doing all that was expected of it, but within a little more that a year from the time its initial installation was put into service its equipment will be eclipsed by an installation at the Fisk St. station of larger and more efficient boilers and turbines. The indications are that the equipment which will be installed at the Northwest Station in the future will be of an entirely different type from that now in use, and we may even hope it will be as great an improvement over the newer Fisk St. turbines as those are expected to be over the present machines in the Northwest Station.

Annual Meeting of the Illinois Water Supply Association

The fifth annual meeting was held at the University of Illinois (Champaign-Urbana, Ill.) on Mar. 11 and 12, with a large attendance and a list of about 40 papers representing various matters relating to the supply, use and treatment of water, the administration of the supply, and the relation of the water supply to the public health. In fact there were so many papers for the five sessions that in some cases discussion had to be checked in order that the program might be proceeded with. A rather undue proportion of the papers dealt with the chemical rather than the engineering side of water supply problems. The meeting was characterized by active interest in all the various subjects presented. The election of officers resulted as follows: President, C. H. Cobb (Kankakee); Vice-Presidents, H. M. Ely (Danville), W. J. Spaulding (Springfield), and E. McDonald (Lincoln); Secretary and Treasurer, Dr. Edward Bartow, Director of the Illinois State Water Survey, Urbana, Ill.

Water Supply and Water Works

A large proportion of public water supplies in Illinois are drawn from deep wells, and a paper by T. E. Savage (University of Illinois) reviewed the studies of the geological formations which have been made by the State Geological Survey. The results of general investigations are checked by comparison with the records of well borings, and the request was made that such records be kept of all deep borings and furnished to the Survey for file. A paper by D. H. Stacks (Moline, Ill.) related to the action of well water upon galvanized pipe, as noted elsewhere, and a third referred to the pollution of wells at Rockford and the use in that city of an auxiliary supply from deep wells with electrically-driven centrifugal pumps in the well. The first of these wells has a six-stage pump and 125-hp. motor, showing on the final test an overall efficiency of 62½% at 1000 gal. per min. against 301 ft. total head. This paper was by G. G. Crane, Superintendent of the Water Department.

A paper on "Water Waste" by W. D. Gerber (Chicago) showed the existence in many cases of serious loss by underground leakage from broken mains and open joints. This applies to small plants as well as to those of large cities, and the only way of discovering such loss is by systematic water-waste surveys. The financial loss resulting from such loss, due to excessive work of the machinery and the heavy draft on the supply (with enlargement of plant or source of supply in some cases).

is not generally recognized by the public or the authorities. The discussion indicated that these conditions are probably very general.

A paper by E. V. Orvis (Waukegan) discussed the legal aspects of financing municipal waterworks, and the appraisal of waterworks properties was dealt with by Douglas A. Graham (Chicago). This paper described four methods of appraisal: 1, the market value of the stocks and bonds; 2, the value of the plant as compared with average values of other similar plants; 3, the past cost; and 4, the cost of reproduction. The last two are the most accurate, and the reproduction method was recommended. A paper on experience with algæ in the reservoir at Quincy, Ill., was presented by W. R. Gelston (Superintendent, Citizens Waterworks Co.); copper sulphate is used regularly for treating water in this reservoir during cold weather.

Water Filtration and Treatment, and Typhoid Fever

Besides references to filters in some of the papers descriptive of waterworks, there were two papers on the recent filter plants at Rock Island and Mt. Vernon, Ill., while Mr. Monfort (Chemist of the Water Department at St. Louis) discussed the efficiency of coagulating basins. The operation of filter plants is perhaps even more important than their design and construction, and this is especially true of the smaller plants; for this reason the most important paper under this classification was one by Mr. Hilscher (Assistant Engineer, Illinois Water Survey) on the condition of small filter plants in Illinois. This paper (an abstract of which we shall publish later) shows a rather general existence of unsatisfactory conditions.

A typhoid epidemic at Rockford was attributed to (1) an air-lift well, (2) a pumping pit polluted by surface water, (3) privy vaults near an old reservoir, and (4) sprinkler connections using water other than the city supply. The well and pump pit were abandoned, vaults removed, and double check valves put on the sprinkler connections. After building a new reservoir it was found to be contaminated by ground water entering the open joints of a conduit from the wells. This pipe will have to be relaid, using bolted flange joints and expansion joints. The new reservoir is of reforced concrete; to prevent seepage, the concrete was made dense by using a very rich mixture, and it was lined on the inside with a waterproofing compound.

A paper on the use of hypochlorite in England, by A. C. Jarvis (Honor Oak Park, London) showed that special attention is given to the removal of taste from the treated water. A paper on "Hypochlorite Disinfection and Typhoid Fever," by C. A. Jennings (Chicago) showed the extensive use and great efficiency of this system of water treatment. At Erie, Penn., the reduction in fever cases and deaths due to the hypochlorite treatment has been regular and consistent. In 1912 there were 125 cases and 8.6 deaths per 100,000, a record which approaches that of European cities. At Cleveland, in 1912, there were 258 cases and 37 deaths, giving a typhoid-fever rate of 5.9, which is the lowest of any of the large American cities.

Two papers dealth with the treatment of Lake Michigan water by this process, and a paper by Arthur Ledcrer and Frank Bachman (Sanitary District of Chicago) discussed the elimination of taste in water thus treated. Their tests indicated sodium sulphate and sodium thiosulphate as satisfactory chemicals for removing the taste. About 1.2 lb. sodium sulphite is required per pound of chlorinated lime, and would add 125% to the cost of lime. One objection to the sulphite is that it deteriorates readily, forming sulphates which have no taste-removing property, and this is especially the case with weak solutions. The sodium thiosulphate has great advantages over the sulphite and is used very extensively. It is required in proportions of 0.28 lb. per pound of chlorinated lime (or about 33% of the weight of the lime); its commercial price is about 1.85c. per lb. in 100-lb. lots. As compared with the sulphite, it is cheaper, it is more stable, it requires a smaller amount, and it adds but 40% to the cost of the lime treatment.

The sterilization of water by ultra-violet light was the subject of a paper by J. R. Davies (Northwestern University). He reviewed the developments following the discovery that the ultra-violet ray of light possesses bactericidal action to a high degree, and described experiments as to the relative value of carbon and iron ores. Turbid waters are difficult to sterilize in this way, owing to the low degree of penetration of the light. Nothing was said in the paper as to the practical application of the process.

The use of permutit for softening water was dealt with in a paper by J. F. Garrett (University of Illinois). The material is an artificial zoölite produced and patented by Dr. Gans, in Germany; it is comparatively new and its commercial possibilities have been investigated only to a limited extent. It may be used either as sodium-permutit for the removal of calcium and magnesium, or as manganese-permutit for the removal of iron, manganese and organic matter. The former is of the greater importance commercially, reducing the hardness of almost any water to zero at very low cost, so that it has great advantages for treating water for boilers, dyeing, bleaching and laundry work. For the last purpose it has special advantages over the lime and soda process, since this cannot soften the water to less than 3½ grains per gal., while the permutit can reduce it to zero; the cost is about the same in either case. The high efficiency and low cost are expected to result in an extensive industrial application of the process.

Miscellaneous Subjects

Two papers dealt with the subject of laboratories. Dr. Park (Health Commissioner of Rockford) outlined the advantages of a municipal laboratory in conserving public health, and a paper by Dr. Lewis (City Chemist of Evanston) described some experiences of a health department laboratory. Dr. Gehrmann (Chicago) described a method of rapid preliminary testing of water for sewage contamination, and Dr. Jordan (Chicago), dealt with methods of bacterial examination of water. Prof. Forbes (University of Illinois) discussed the biological and chemical conditions on the upper Illinois River before and after the opening of the Chicago drainage canal, which discharges into this river. Of a different character was a paper on hydrotherapy, or the use of water (liquid, solid or vapor) in the treatment of disease, by Dr. Norbury (Illinois State Board of Administration). The relation between vital statistics and waterworks was discussed by Mr. Hansen (Engineer of

the State Water Survey), and at his instance a resolution was adopted endorsing a bill which is to be presented to the legislature, providing for vital statistics that will be recognized by the American Public Health Association and the U. S. Census Bureau. At the present time, the statistics in Illinois are so incomplete that they are not accepted and the state is "outlawed" in this respect.

In a paper on "Water Required by Railways," C. R. Knowles (Illinois Central R.R.) estimated that in Illinois 1,236,838,000 gal. of water are used annually by locomotives; 1,751,790,000 gal. of this are purchased from waterworks plants, and 138,645,000 gal. are treated by purifying plants owned by the railways. Adding the water for washing and filling boilers, for power plants and sanitary purposes, the total annual consumption is 5,736,838,000 gal., of which 13% is purchased from city plants. Mr. Knowles thought this proportion would be greater if lower rates were made, but in many cases they are so high that the railway finds it cheaper to build its own plant.

A paper by S. G. Pollard (Cincinnati) dealt with the proper methods of operating a pumping plant to insure a high degree of efficiency. Mr. Amsbary (Superintendent, Champaign & Urbana Water Co.) discussed the use of the flushometer type of water closet, and this led to a general discussion as to the proper size for the pipe connections. Mr. Stacks (Moline) described the effect of artesian water in removing the zinc coating from galvanized pipe, causing zinc poisoning among persons using the water. Mr. Fleming (University of Illinois) described some experiments with fire streams from small hose and nozzles.

We give below notes from a few of the papers noted in the above report of the meeting.

EFFECT OF ARTESIAN WATER UPON GALVANIZED PIPE*

To supply drinking water throughout a manufacturing plant, a well was sunk 1467 ft. to the St. Peter sandstone, and tests showed the water to be of excellent quality and with a mineral analysis of ordinary character, although the water as it issues from the pump has a strong odor of hydrogen sulphide. The distribution system, completed in October, 1911, includes about 20,000 ft. of galvanized steel pipe and 300 fountains of the valve type. Owing to the large number of fountains, it was necessary to keep their valves closed when not in use, especially after working hours. About 30 days after the water system had been in operation there were complaints about the water, and many of the employees suffered cramps, fainting spells and nausea soon after drinking the water. Inspection showed that the water appeared cloudy and contained a white sediment, which analysis proved to be zinc; this was not found in the water as it came from the pump. Tests of the pipe proved the action of the water upon the metal, and microscopical examination disclosed pitting as well as large patches where the zinc coating had been removed entirely. The water was found to contain as high as 1.80 grains of zinc per gal., with an average of 0.5 grains. When the trouble was at its height an average of 40 to 50 men were ill daily, and many were confined to their homes for several days.

As conditions grew worse during the 60 days occupied by the investigation, experiments were made as to the possibility of removing the zinc without injuring the pipe seriously. It was found that a 5% solution of sulphuric acid would remove the greater part of the zinc in three hours, when the action ceased. The engineering department estimated that about 700 gal. would be required to fill the pipe system, and a pump was installed to handle the acid solution. On a Saturday night the system was drained, and air blown through it. On Sunday morning the valves at the fountains were all shut and the pipes were filled with the solution in about 35 min., each valve being opened until air and gas were driven off and the fountain showed a full flow. The pressure required was from 70 lb. at the beginning to 125 lb. at the end. After three hours the acid was drained off. The pipe system was then connected to the feed-water pipe of the boilers, and hot water containing boiler compound was pumped through for several hours, after which it was connected to the well pump and well water forced through the pipes until they were thoroughly washed. The work was completed in time to have the water supply in use Monday morning. This treatment was repeated in 30 days, after which the water contained but a slight trace of zinc.

A medical inquiry showed very little information as to zinc sulphide. It appeared that the smallest dose of zinc-sulphate fatal to adults is 15.5 grams; the dose as an emetic, 1 gram; the regular dose 0.016 to 0.032 gram, or 0.25 to 0.5 grain per gal. With the average condition of the water it would be necessary to drink one to two gallons of water to get a full medicinal dose, but as the opening of the valve would raise a large amount of zinc-sulphide that had collected in the pipe, this would be swallowed so that much less than a gallon of water would cause serious results. The entire pipe system will have to be renewed in a short time, involving considerable expense and inconvenience.

*By D. H. Stacks, Chief Chemist for Deere & Co., Moline, Ill.

WATER SUPPLY AND POLLUTION AT ROCKFORD, ILL.*

This city has a municipally owned (and in the past politically operated) water department. In March, 1912, there existed a disastrous epidemic of typhoid fever, which the experts employed credited to the city water supply. The plant consisted of a number of deep wells (connected with the shaft and tunnel system) from which the water was raised by low-lift centrifugal pumps and delivered into the pumping pit. From this pit the high-pressure engines took the water and delivered it direct to the service mains, but by means of a by-pass some of the water was delivered to a concrete reservoir of 1,200,000 gal. capacity. One of the wells was also operated with an air-lift, and two other wells with motor-driven impeller pumps.

Dr. Jordan placed the blame for this epidemic: 1, upon the well operated by the air-lift; 2, upon the pumping pit, through the walls of which leaked a quantity of polluted surface water; 3, the old reservoir, which was closely surrounded by privy vaults. Mr. Hansen, of the State Water Survey, pointed out the possibility of contamination through fire-protection sprinkler connections, where water was used foreign to the city supply. Substantiating his theory was the fact that the majority of the cases of intestinal grip usually followed by typhoid fever originated and were located in certain sections of the city where it was possible for the water to be affected through sprinkler connections. Tests of all sprinkler connections proved the necessity of protection. This was accomplished by the installation of special double check valves wherever other than city supply was in use, and these sprinkler connections were further guarded by regular monthly inspections.

The evils at the pumping station were corrected by the abandonment of the air-lift well and the pumping pit, removal of the privy vaults, and construction of a new reservoir. After the completion of this reservoir it was discovered that contaminated water was entering it from a conduit line leading from two of the wells. It was found that every joint of this line was leaking and whenever the water in the new reservoir was drained off, this conduit line offered a ready path for the polluted ground water. This line was cut off from the system and has undergone a complete overhauling, but will have to be relaid, with flanged and bolted joints and expansion joints at intervals. The condition of the joints in this conduit line was the result of expansion and contraction, as these wells were only pumped intermittently.

Hypochlorite of lime was used until July, when careful tests proved it was no longer necessary. The last cases of typhoid fever traceable to the city water supply were reported early in May.

The new reservoir is of reinforced concrete, circular in shape, roofed with a concrete dome, and the walls above the ground are covered with brick veneer. The floor, side-walls and roof, each in turn, were made in one pouring of concrete. To make the concrete impervious to seepage, a very rich mixture was used and the reservoir was lined inside with a water-proofing compound. This reservoir cost $19,663.

DEEP-WELL PUMP—Well No. 7 is the result of a recommendation offered by a special commission appointed by the city in 1910 to make report on an increased water supply. This is an experiment with what is known as the unit well system.

*By G. G. Crane, Superintendent of Water Department, Rockford, Ill.

the object being to locate several of these wells in the different outlying portions of the city. The new well will be electrically operated. Originally it was specified to be 1500 ft. deep, the first 200 ft. to be 16 in. casing and balance 12 in. casing, but the diameter of the larger casing was increased to 18 in. to permit the installation of a multi-stage turbine-type deep-well pump. The purchase of the equipment for this well was not based upon specifications, but the bidders were instructed that the contract would be awarded to the company agreeing to furnish equipment of the highest operating efficiency at the lowest maintenance cost, for a given period of time; cost and delivery were secondary considerations.

WATER FILTRATION PLANT AT MT. VERNON, ILL.*

Although no sewers empty into the creek from which the supply is taken or the three reservoirs, the water is contaminated and has always been unsafe for domestic purposes. There has never been any typhoid epidemic, and 95% of the typhoid cases can be traced to cisterns or out-of-town sources. There is a great accumulation of silt, and although the mains were cleaned last year, the pressure is already decreasing due to the fresh accumulations. The company decided to put in a filter plant in order to improve the supply, to increase the number of consumers and to reduce the expense of cleaning mains and renewing services. The plant is of 1,500,000-gal. capacity, with Pittsburgh filters.

The concrete of the walls and floors is watertight, being made very dense with a very wet mixture of 1 cement, 1 sand and 4 coarse chatts (from lead mines). The mixing chamber is 9x17 ft., and 12 ft. deep; it has five sets of baffles, after passing which the water flows through a 16-in. tile in the sedimentation basin; this is 87x35 ft. and 12 ft. deep, and is divided by a baffle well, so that the water travels twice the length of the basin before passing over the skimming wall to the skimming trough. The three filters are 11x16 ft., 9 ft. deep, with cast-iron manifolds having ⅜-in. strainers 6 in. apart. They contain 6 in. of coarse 1-in. gravel, 6 in. of ⅝-in. gravel and 32 in. of sand of 0.36 to 0.56 mm., with a uniformity coefficient of 1.70. The filtered water passes out through balanced valves guaranteed to control the flow within 3% of any desired rate of filtration.

The Water flows to a clear well of 75,000 gal. capacity, having a connection with the new 150,000-gal. water tower, giving a fairly good reserve in case of fire. The water from this tower (with pressure reduced to 10 lb.) will be used for washing the filters, and no air will be employed unless it is found necessary; as this use of water alone requires a greater quantity, the size of the wash pipe had to be increased from 6 in. to 8 in. The pipe gallery contains three motor-driven centrifugal pumps; one of these is for fire service, but the others can be cut in to help in case of a large fire. The alum can be fed at the mixing chamber, the outlet end of the sedimentation trunk, or the skimming trough, according to the condition of the water. Lime (when necessary) will be fed into the mixing chamber, and hypochlorite into the flume before entering the filters. The plant will not be in operation till after the middle of March.

FILTER PLANT AT ROCK ISLAND, ILL.†

The rapid sand-filter plant at Rock Island, Ill., was put into continuous operation March 28, 1911. It has a capacity of 6,000,000 gal. per 20 hours with two settling basins which have a coagulation period of from four to twelve hours when the plant is operated at full capacity. This plant is built within one of the old 1,000,000-gal. slow sand-filters of which there were three, and gives a good ocular demonstration as to the amount of space that is required for the two types of filters.

The coagulant is applied to the raw water at the inlet of the basins, and after passing through the basin the treated water is conducted to the filters by a 30-in. conduit into which the bleach is applied about 25 ft. from the filters. There are six filter units, each 24x17 ft., with a filtering area of 365 sq.ft., equipped with separate manifolds so that the air and water may be applied at the same time during the washing period if desired. Each filter has three concrete wash troughs giving a maximum lateral flow of the soiled wash water of 2 ft. from any part of the filter to the weir of the troughs. The water collecting system and the underdrain piping of the filters (except the strainers) are entirely of cast iron embedded in concrete, with brass strainers set at 6-in. centers. Each filter is equipped with recording loss-of-head gases, outlet rate controllers and hydraulically operated valves, while all pumps and other machinery are operated by electricity.

According to the specifications the plant was required to produce a filtrate having less than 100 bacteria per c.c., except that when the raw water contained over 3000 bacteria per c.c., the production should be at least 97% and the wash water was not to exceed 5% of the amount of water filtered. In the test, the average bacterial count for the raw water was 1875 per c.c. (max. 3150, min. 1075). The average for the settled water as it passed to the filters was 110 per c.c. (max. 450, min. 32). The average for the filtered water was 27 per c.c. (max 80, min. 6). This shows that the average removal between the total raw and filtered water was 98%. About 8 lb. of bleach per million gallons of water was used from May 31 to June 20; the balance of the test was conducted with sulphate of alumina alone, an average of 3.6 grains per gal. was used (max. 5, min. 1.5). The average color was reduced from 75 to 20 parts per million, and the average alkalinity from 96 to 67 parts per million, while the removal of the turbidity was complete.

In the raw water, gas formers were found in all but three of the samples. In the filtered water, all but one of the samples were negative while the bleach was being used, but out of 20 samples that were taken after the bleach was discontinued, 9 showed gas formers. The average amount of wash water used during the test was 2.4% of the amount filtered (max. 4%, min. 0.8%). During 1911, the average colony count in the raw water was 6448 per c.c., with 84% of the samples showing gas formers. For the filtrate, the average count was 168 per c.c., with 9% of the samples showing gas formers, and the color was reduced from an average of 62 to 24 parts per million. During 1912 the average colony count in the raw water was 7660 per c.c. with 82% of the samples showing gas formers. For the filtrate, it was 67, with 10% of the samples showing gas formers, and the color was reduced from an average of 75 to 15 parts per million. During this time alum and bleach was not used in parallel at all times, but was alternated from time to time to check up the different modes of operating the plant with the various changes in the raw water.

About a month after the test on the plant considerable difficulty was experienced with the coagulant feed pipes, which are about 350 ft. in length. The first installation was with lead-lined iron pipe, which proved unsatisfactory, and was replaced with fiber pipe and rubber hose on July 8, 1912; this has given much better results

*By S. B. Severson, Manager of the Citizens Gas, Electric & Heating Co., Mt. Vernon, Ill.

†By R. W. Sharp, Superintendent of the Water Department, Rock Island, Ill.

Cost and Maintenance of Stone Ballast

An investigation made by the Pennsylvania R.R. as to the cost of laying and maintaining stone ballast, using stone of different sizes, is recorded in the report of the Committee on Ballast, presented at the annual meeting of the American Railway Engineering Association, at Chicago, Mar. 18-21. The experimental stretch of double track was three miles in length, one mile being laid with ¾-in. stone, one with 1½-in. stone and the third with 2½-in. stone. The investigation covered the period of 51 months between August, 1899, and October, 1903 (inclusive), and indicated a lower cost in all respects for the larger sizes.

The main features of the results are shown in the accompanying table:

TABLE OF RELATIVE COST OF STONE BALLAST OF DIFFERENT SIZES

Size of stone	¾ in.	1½ in.	2½ in.
Double-track ballast, feet	5280	5211	5280
Double-track ballast, miles	1.0	0.987	1.0
Stone ballast, cars	228	171	198
Stone ballast, tons	6200.5	4651.8	4947.9
Cars stone per mile double track	228	173	198
Tons stone per mile double track	6200	4713	4948
Lin.ft. double-track to 1 car	23.1	30.5	26.7
Lin.ft. double-track to 1 ton	0.85	1.12	1.07
Ave. depth ballast under ties	7.25 in.	6.5 in.	6.75 in.
Total first cost of ballast, freight, unloading, putting in tracks, lining and surfacing, etc.	$7911.60	$5633.51	$5263.92
Ave. cost per ft. double track	1.50	1.08	0.997
Ave. cost per mile double track	7911.60	5708.10	5263.92
Cost ballast per ton at quarry	60-70c	60-68c	58-69c
Ave. cost of maintenance for period of 51 months, per mile	$94.66	$84.94	$82.13

A New Railway Freight Terminal at St. Louis

SYNOPSIS—The reconstruction and remodeling of city freight terminals is a class of work which most railways have in hand more or less frequently, in order to adapt their facilities to the growth of business and the requirements for efficiency and economy of the freight service. The following article describes a recent piece of work of this kind at St. Louis, Mo. One feature of this terminal is the construction of a five-story freight house; only the first floor is needed for ordinary freight business, and the upper floors are for warehouse or storage purposes. This is an economical utilization of high-priced land, as it provides revenue-producing facilities on an area where only a one-story structure would be needed for the railway use of the terminal. The freight house is designed for the handling of freight by trucks in the usual way, the railway officials considering that as yet no mechanical system of freight handling offers greater economy or advantages in ordinary freight-house work. With this view, the building is designed to secure a high degree of efficiency with the trucking system.

A large new freight terminal, including a freight yard and combined freight house and warehouse, has been built at St. Louis, Mo., by the St. Louis Southwestern Ry., and this takes the place of old facilities which were quite inadequate for handling the increasing volume of freight under the growth of the company's business. The new terminal has been made of ample capacity for a further increase in business, and special care has been taken to make it efficient and economical in operation. About 90% of its traffic is outbound. The cost of the building was about $300,000, while that of the entire terminal, including land, was about $2,000,000. This new terminal was designed and built under the direction of C. D. Purdon, Chief Engineer of the St. L. S.-W. Ry. System; O. D. Schmidt, Chief Draftsman in the Bridge and Building Department, was architect for the building. The general contractors were Thompson & Scott, and the steel frame was fabricated and erected by Christopher & Simpson. The plumbing and heating system was installed by the Wm. Burke Plumbing Co., and the sprinkler system by the Globe Automatic Sprinkler Co. E. W. Samen was superintendent for the contractors, and Winters Haydock was resident engineer for the railway company. For information we are indebted to Mr. Purdon and Mr. Haydock. The terminal was opened for business on Jan. 1, 1913.

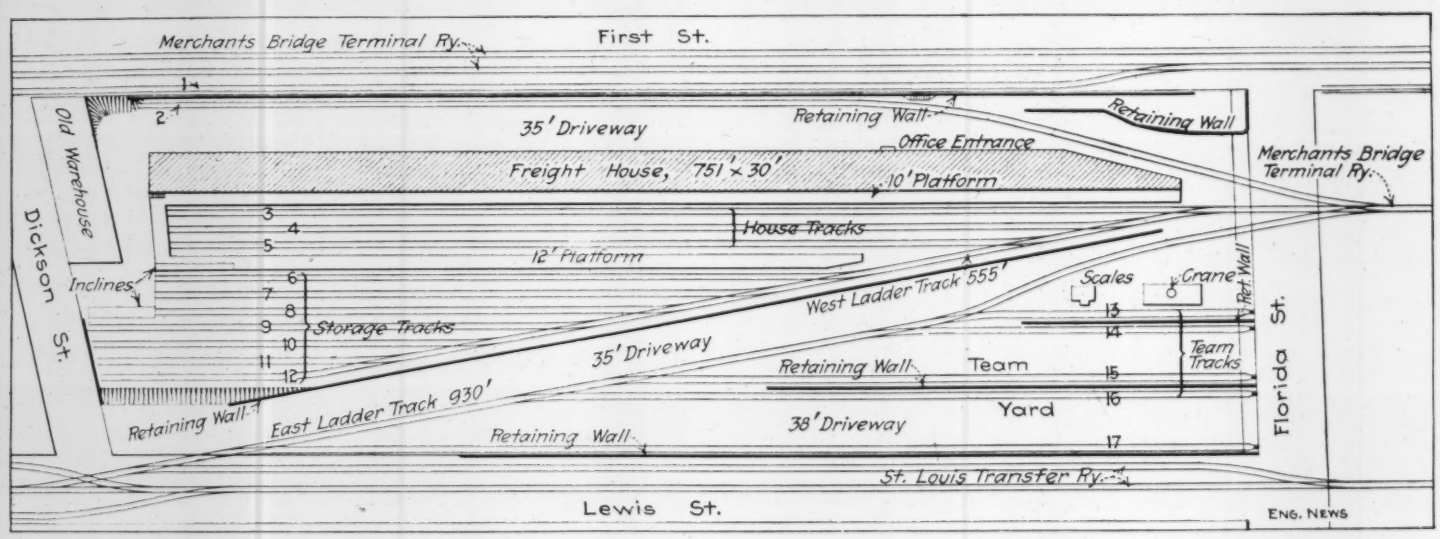

FIG. 1. PLAN OF NEW FREIGHT TERMINAL AT THE ST. LOUIS SOUTHWESTERN RY. AT ST. LOUIS, MO.

LAYOUT FOR TERMINAL

The new terminal occupies three city blocks and lies between 1st and Lewis Sts., and Florida and Dickson Sts., as shown in Fig. 1. It is about 874 ft. long and 274 ft. wide. The main line tracks of the Terminal Railway Association, leading from the Merchants Bridge, are on 1st St. (west of the property), and the tracks of the St. Louis Transfer Ry., which is a part of the Terminal Railway, are on Lewis St. to the east. Lewis St. is about 20 ft. lower than 1st St., and Florida and Dickson St. at the north and south ends of the property respectively, slope down from 1st St. to Lewis St. on a grade of 7%. For the fullest utilization of the property, which has been bought at great expense, it was necessary in designing the yards to plan for a connection with the tracks both on 1st St. and Lewis St. This involved a serious difficulty on account of the difference in elevation of these tracks and the steep slope of the property. The final arrangement was adopted as providing a maximum of convenience of operation with a minimum waste of space, and requiring no steep grades. This is shown by the typical plan and section in Figs. 1 and 2.

The principal features of the terminal are as follows: a five-story freight house, 751x30 ft.; a yard of ten tracks to serve the freight house and for the storage of cars; a covered transfer platform 500 ft. long; and a team-track yard of five tracks. The spacing of track centers is 12½ ft. in general; 25 ft. at the freight platform and 38 ft. at the team driveways. The difficulty of getting tracks into all four corners of a comparative small rectangular area was overcome by running two ladder tracks diagonally through the property; from one of these the house and storage tracks lead toward the south, and from the other the team tracks lead toward the north. Between these two tracks is a diagonal driveway between Florida

and Dickson Sts., forming a connection with the ends of the driveways between the team tracks. In the team-track yard, the elevations of the tracks and driveways conform in general to the 7% slope, the various levels being divided by small retaining walls. The typical section of these walls has a top width of 27 in. (including a 3-in. projection for the 12-in. coping); the batter

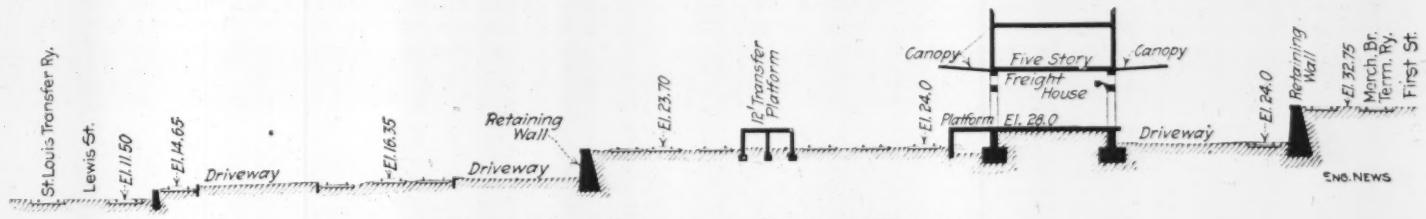

FIG. 2. CROSS-SECTION OF FREIGHT TERMINAL

is 1 in. per ft. on the face and 3½ in. per ft. on the back. The driveways of the team yard are paved with granite blocks and have concrete curbs. This yard has a wagon scale and a crane of 25-ton capacity mounted in the middle of a concrete platform. The track capacity of the terminal is given in the accompanying table:

CAR CAPACITY OF FREIGHT TERMINAL; ST. LOUIS SOUTHWESTERN RY.

Track	Length, ft.	No. of cars	Track	Team-yard tracks Length, ft.	No. of cars
1. Siding	935	19	13. Team	240	3
2. Team	930	14	14. Team	240	3
3. House	835	18	15. Team	440	9
4. House	905	15	15. Team	510	10
5. House	640	14	17. Team	760	13
6. Storage	510	11	Total		38
7. Storage	460	9	Grand total		163
8. Storage	400	7			
9. Storage	380	6			
10. Storage	295	6			
11. Storage	230	3			
12. Storage	230	3			
Total		125			

FREIGHT HOUSE AND WAREHOUSE

The design of the freight house was adopted in the belief that though various systems of handling freight have been tried, such as telferage systems, hoists, motor trucks, etc., nothing can surpass for economy the simple plan of trucking freight to or from the cars through a narrow building. Hence the building was made long for capacity and narrow for economy of operation. The building is 751 ft. long and 30 ft. wide, and has a 10-ft. platform on the track side. On the west side is a driveway paved with brick. Steel rolling doors are provided on each side of the building for a series of doorways 11 ft. wide and 9 ft. high, separated by 30-in. piers. The windows of the warehouse floors are 11x3 ft. On each side is a steel-framed concrete canopy, 12 ft. wide. At short intervals along the middle of the building there are platform scales, set in the floor.

The building is five stories high, and has no basement under the main portion. It is of fireproof construction, having a steel frame with concrete walls, floors and roof. Fig. 3 is a sectional elevation, with floor-framing plan; Fig. 4 shows the steel framing, and Fig. 5 shows certain details. The panels between floor centers are 13 ft. 6 in. The floors are designed for a load of 500 lb. per sq.ft.; the roof and the canopy or awning for a live load of 50 lb. per sq.ft., and the platforms for 300 lb. The four upper stories are intended for warehouse purposes and are served by four electric elevators. This extension of the plan to include a large warehouse area without using any more ground space was warranted by the permanent demand which exists for such space in St. Louis, and by the additional freight business which such a warehouse connection would naturally bring. Each floor is divided into compartments about 100 ft. long by division walls having openings 12 ft. wide, which are provided with rolling steel doors having automatic fire latches. The entire building is protected by an automatic sprinkler system. The building is made as pleasing in appearance as its massive design and utilitarian purpose warrant. The flatness of the concrete surface is relieved by lion heads at the ends of the canopy rods, shields at the corners and a large sign; all these decorative features are in verde-green terra-cotta.

Near the north end of the building, on the first floor, is a large office for the bill clerks and cashier; and above this on the second floor is a larger office for the freight agent and his clerical force. On the first and second

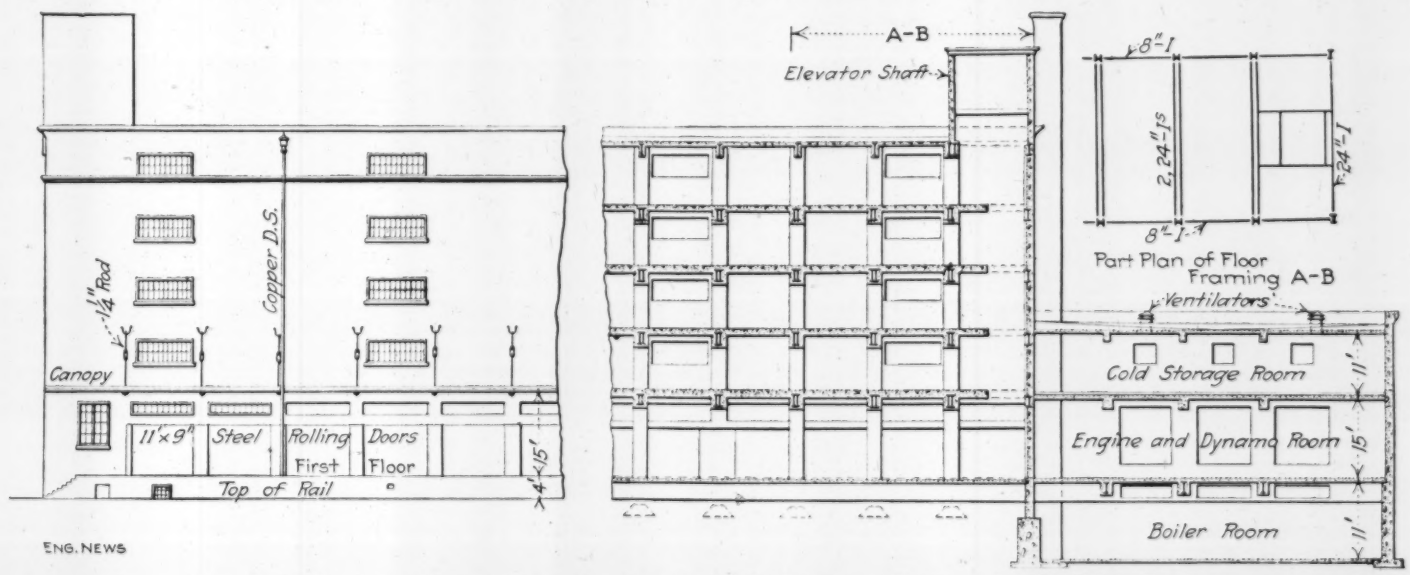

FIG. 3. PART ELEVATION AND SECTION OF FREIGHT HOUSE; ST. L. S-W. RY.

floors are seven toilet rooms. These and the offices are heated by steam from a boiler located in the cellar of the two-story portion of the north end of the building. The vacuum system of steam heating is used. One compartment on the third floor is also heated; this being intended

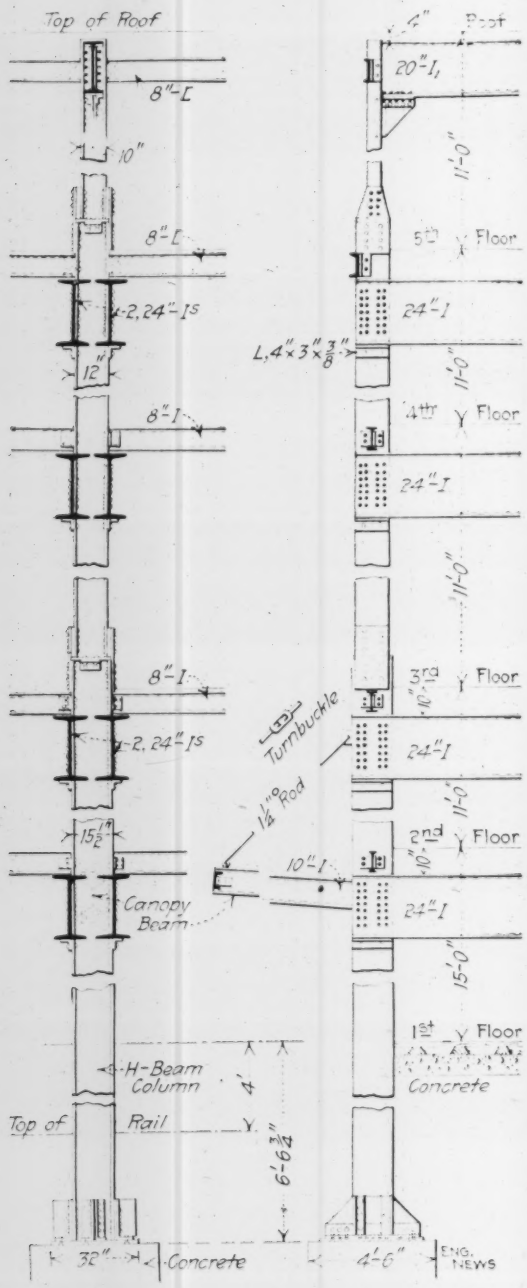

FIG. 4. STEEL FRAMING OF FREIGHT HOUSE

for use as a storeroom for fruit. Above the boiler room (in the basement) is a two-story building, having the engine and generator room on the first floor and a refrigerator room on the second floor. This latter room has a capacity of about five carloads of freight, and is served by a special elevator. The walls, floors and roof of the room are insulated with 3-in. cork slabs and refrigeration through ammonia pipes is provided by the St. Louis Cold Storage & Refrigeration Co.

In order to provide for the transferring of freight from car to car, a reinforced-concrete platform about 500 ft. long and 12½ ft. wide, with shed roof, has been built between the third and fourth tracks east of the freight house (Fig. 1). This is connected with the building by a cross platform at the south end. A convenient feature is a concrete loading incline at the end of one of the tracks, providing a ready means of loading traction engines, threshing machines, boilers, fire trucks, automobiles, etc.

The steel structural framing is shown in Fig. 4. The columns are steel H-beams, 14x15½ in. for the first two stories, and 12x13 in. for the next two, while in the top story the columns are 10-in. I-beams. In all cases the web is parallel with the side of the building. The transverse floor-beams are pairs of 24-in. I-beams, while the roof girders are single 24-in. I-beams. The longitudinal members between the columns are 8-in. I-beams and channels. The roof girders rest on top of the columns, but the floor beams have the inner flanges coped so that the webs are riveted against the faces of the columns, while the outer flanges rest on angle brackets. The canopy roofs are carried by inclined 10-in. I-beams, 13 ft. long, the inner end of the beam rests on an angle bracket on the column web while the outer end is attached to a 1¼-in. hanger rod whose upper end is fitted to an anchor plate on the column. Along the ends of the I-beam runs a 6-in. channel as a fascia beam. The columns have riveted shoes with ¾-in. base plates 32x42 in. and these are placed on top of the concrete footings. Fig. 5 shows the concrete floor slabs and the concrete casing of the beams. The outer walls are of 8-in. concrete, reinforced with horizontal and vertical ⅜-in. rods spaced 12 in. apart. Over the door and window openings (11 ft. wide) are laid ¾-in. bars, and the lintels over the doorways are reinforced-concrete girders. The floor slabs have ⅜-in. transverse bars 24 in. apart, and ¾-in. longitudinal bars 6½ in. apart. The main roof and canopies have all ⅜-in bars, with 5-in. spacing for the longitudinal bars. In the two-story portion, the first floor has floor girders of pairs of I-beams encased in concrete, while the second floor and roof have reinforced-concrete beams and slabs. In the main building, the first floor has a flooring of maple 1¾x2¼ in., spiked to creosoted pine sleepers 3½x6 in., which are spaced 18 in. centers and rest on the concrete base. Concrete filling is placed between the sleepers to a depth of 3 in., leaving a 2½-in. air space below the floor. The floor planks are laid

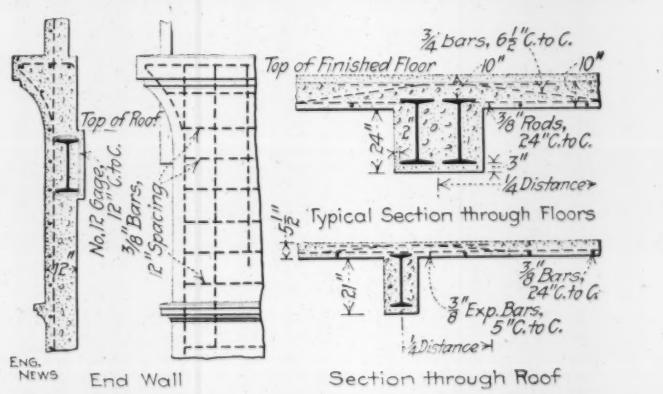

FIG. 5. REINFORCED-CONCRETE WALLS, FLOORS AND ROOF; AND CONCRETE CASING OF FLOOR AND ROOF BEAMS

transversely, but on the platform they are laid longitudinally.

CONSTRUCTION WORK

The work of tearing down the old buildings of the Charter Oak Stove Co., from which the real estate was bought, was begun in September, 1911. Wrecking and

grading were then carried on, but the severity of the winter prevented the accomplishment of much, except the erection of the steel frame. The tower and chute system was used in concreting, supplemented by hopper cars for the long hauls. About 15,000 cu.yd. of concrete were used in the entire construction. The long and narrow form of the building lent itself admirably to economy in form-work. The outside wall forms were built in large panels 40 ft. 6 in. long and one story high. The beam, floor and inside wall forms were built in small panels, light enough to be handled by two men. The concrete was poured in sections including about one-quarter of one story. While one of these sections was being concreted another was being erected by the carpenters; then the form panels of the first were moved to the next section, and thus the forms were used over and over. The large outside panels were moved along the building and from story to story by a wooden traveler, which ran on rails temporarily placed on the longitudinal beams of the steel roof framing. They were handled from the traveler by multiplying-chain hoists. A smooth and uniform surface of the concrete walls was secured by the use of dressed lumber for the forms, and no finishing treatment was used after the removal of the forms. The concrete was a 1 : 2½ : 5 mixture, made with stone principally, but some gravel was used when the supply of stone ran short. The maximum size of the stone was such as would pass a 1-in. ring. The concrete was mixed to a "sloppy" consistency, so that it could flow freely in the inclined chutes. As there was a large amount of stone masonry in the old building, and also brick, for which there was little or no sale in St. Louis, a crusher was installed on the site. The crushed stone (hard limestone) was used for the concrete, and the crushed brick was used for ballasting the tracks, this being in effect burned-clay ballast.

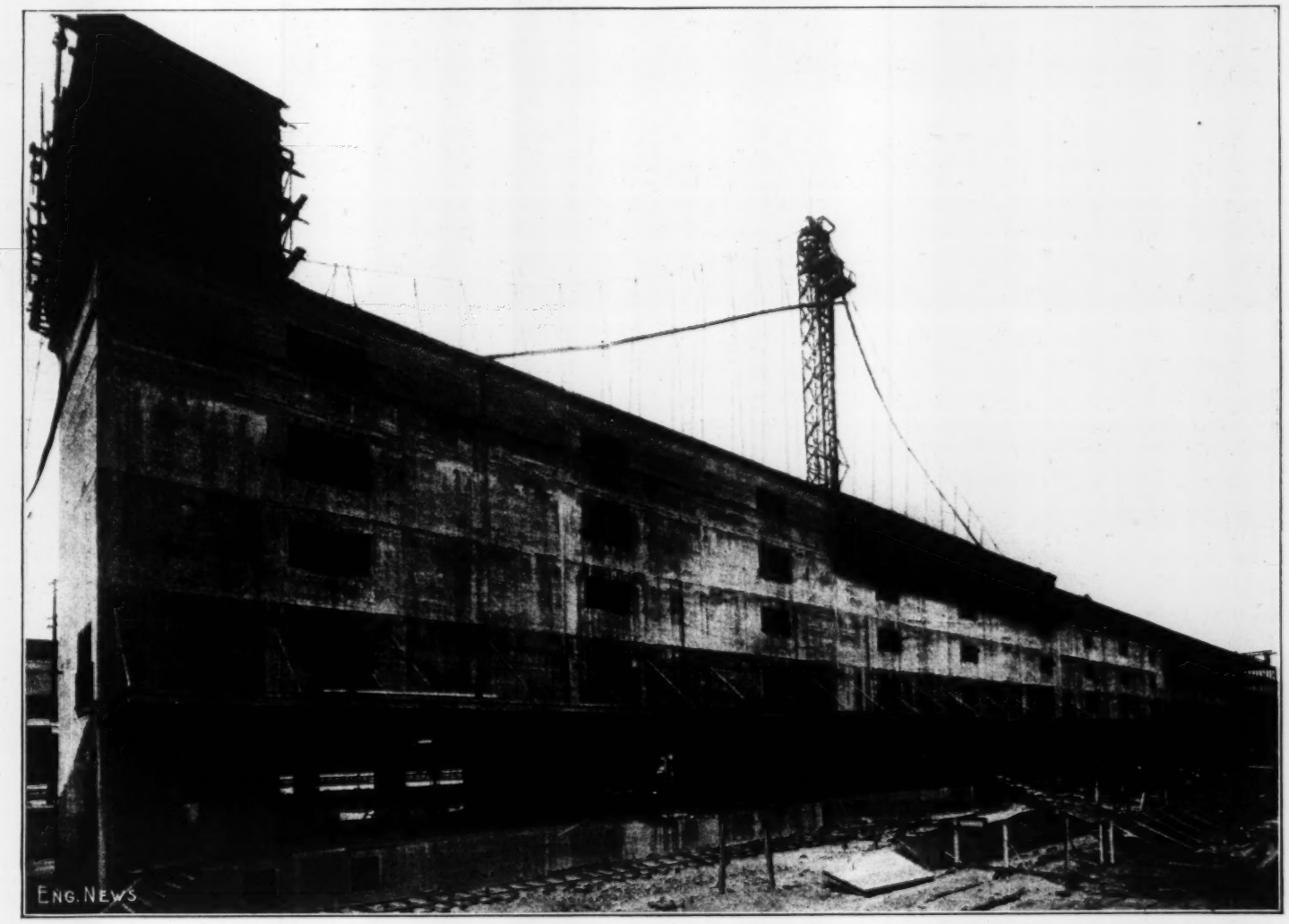

FIG. 6. CONSTRUCTION OF FREIGHT HOUSE AND WAREHOUSE FOR THE ST. LOUIS SOUTHWESTERN RY. AT ST. LOUIS, MO.

(The tower and spouts for the concrete work are shown at the middle. The forms for the elevator tower at the left are suspended from blocks on the projecting beams.)

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Boiler Inspection Standards and Regulations will be uniform throughout the Canadian provinces, after July 1, as a result of much negotiation between representatives from the different provinces. These regulations provide for the rigid inspection of all boilers, during construction, to see that proper materials and safe methods are employed. The object in making the regulations uniform is to insure a uniform degree of safety and to enable a certificate, granted in respect to a boiler in one province, to be accepted in any of the others.

To carry out the provisions of the act the province will be divided into districts with a chief inspector and two or three district inspectors. These inspectors will be given ample discretionary power in their work, with authority to insist on a proper standard of efficiency being maintained. Hitherto there has been no such system of inspection. Steamboat and railway boilers are not included, as these are dealt with in a separate act. Once a boiler is inspected and installed it passes under the jurisdiction of the inspectors under the Factories Act. But where an old boiler is resold that has not been examined within one year of the time of sale, it may not be moved and applied to new work without a further inspection.

Foreshore Protection by Reinforced-Concrete Groins

The protection of foreshores against erosion by the use of groins or jetties is not very usual in this country, but in England and the continent of Europe it is a common practice. As a rule, these groins are of masonry or timber, but recently in England some successful reinforced-concrete groins have been built near Brighton. These are described in a paper before the Institution of Civil Engineers by Messrs. Owens and Wood.* The occasional need of such construction in this country is sufficient excuse for the abstract of this paper given below.

The works referred to in the paper are located on the Sussex coast of England, about 6 miles east of Brighton. The chalk cliffs here vary between 40 and 120 ft. in height, the average batter of the cliff-face being about 1 in 12, although in places the cliff overhangs. The foreshore consists of practically bare chalk with a little shingle along the toe of the cliff at certain points. There is considerable littoral drift of the shingle and an abundance of sand at and below low-water mark. The preponderate drift of shingle (from west to east), and the action of the sand and the wave had been cutting under the cliff at the rate of about 3 ft. per annum for the 11 years preceding 1907. Along the top of the cliffs very close to them, as shown in the portion of the shore in Fig. 1, a main road with the main outfall sewer from Brighton runs, and the steady encroachment of the sea threatened to destroy not only the road but the sewer. It was, therefore, necessary to provide some protection at the foot of the cliff to prevent its continued erosion.

Early Construction

In 1907, work was commenced at the west end of the cliff at the location shown in Fig. 1, and five reinforced-concrete groins were built there by the authorities of the neighboring towns. These groins are shown in Fig. 1 as Groins 1 to 5. Groin 6 there shown is somewhat similar to Groins 1 to 5, but was built later, and later still Groins 7 to 19, the latter nine of which are not shown in the drawing, were built according to a somewhat similar design as the one for Groins 1 to 5.

The design for Groins 1 to 5 is shown in Fig. 2. It consists essentially of a reinforced-concrete fence extending from low water to the base of the cliff and at right angles to the latter. Each groin comprised a series of columns 16 in. square in cross-section and spaced 5 ft. 6 in. apart from center to center for the first 200 ft. from the cliff and thence to low water 7 ft. apart. The spaces between the columns were closed by slabs 6 in. thick and 1 ft. deep, dropped into position in grooves molded in the sides of the columns. These slabs were fixed in their grooves by means of cement grout which was run in from the top after the sides of the opening between the slabs and columns had been filled with cement mortar. The columns were fixed in concrete in holes excavated in the solid chalk to a depth of 2 to 4 ft., depending on the height of the column. They stood 8 ft. clear at the cliff, gradually reducing in height to 2 ft. 6 in. at the leaward end.

The reinforcement of the columns consisted of four 1¼-in. round steel rods tied together by links of ¼-in. steel wire at intervals of 6 in. The column was of the section shown in Fig. 2, the slabs being held between the flanges. In order to support these flanges, short, straight rods of ⅜-in. steel were placed across the main rods and projected into the flanges. It was found that these were too easily displaced and reliance could not be placed on their remaining in their proper position while ramming the concrete into the forms, which were placed horizontally on the ground in molding the columns.

As it was anticipated that the greatest accumulation of material would occur on the west or windward side, the columns, where they were over 5 ft. above their base, were provided with raking struts of reinforced concrete on the east side. These struts were the source of considerable trouble later, owing to the severe grinding action of the flint boulders about the base. As the columns were erected, two or three slabs were fixed in each bay, the intention being to increase the height by the addition of more slabs as the shore-level was raised.

It is stated that the groins commenced to collect material as soon as they were erected, chiefly coarse flint, but sand at certain points. The accretion of flint shingle was almost entirely on the west side of the groin in the form of a triangle in plan, having its base against the collecting groin and its apex some point between this and the next to windward. The apex of each triangle gradually extended to windward as more material collected. Thus for a considerable distance the cliff was protected

Fig. 1. Portion of Protected Shore near Brighton, Eng.

by the shingle, the falls of chalk, which have been of constant occurrence during previous winters, became less frequent. Sections of the foreshore showed that between September, 1907, and December, 1908, the quantity of material collected by the groins was approximately 6247 cu.yd.

Where they are beyond the action of flint boulders, the groins have suffered no damage at all, except that two or three slabs were broken out of their bays by a floating piece of wreckage during a gale. Where, however, the landward ends were exposed to the action of large irregular flints present in any quantity, a certain amount of attrition of the concrete was noted. This attrition first showed itself upon the corners of the columns and the lower parts of the struts on the east side of the groin. In some cases the faces of the slab suffered also, but not to the same extent as the columns and struts. Careful observation of the attrition showed that it was due chiefly, if not almost entirely, to two or three special factors. In the first place the method of making a strut and columns on land with unfinished ends and subsequently uniting them on the foreshore by filling concrete into the forms built around the junction did not permit these parts to become properly seasoned before they were exposed to the grinding action of the flint. It was also found that the concrete made from flint shingle suffered in a curious

*"Reinforced-Concrete Sea Defenses," by John Switzer Owens and Frederick James Wood. Paper No. 3998, The Institution of Civil Engineers, London, Eng.

way. When a heavy stone was driven by the sea against the concrete, frequently one of the flint pebbles on the surface was struck and shattered, and the splinters soon worked loose, leaving the empty socket, the edges of which soon wore down until a fresh pebble was exposed and thus the process went on.

In all repairs, therefore, a very tough granite was used for the concrete, as this showed much better wear under the severe conditions. In making the repairs there was no indication of rusting of the reinforcement, except where the small cross rods for reinforcing the flange of the column had been permitted to come too close to the surface. In these cases small patches of rust appeared on the surface of the concrete, but no harm seemed to result. Slabs which had been in the work for a year or more were broken open and the steel was found to be free from rust.

Wall Protection

At Groin 6 (Fig. 1) the proximity of the road to the cliff led to the decision to protect the toe of the cliff at this part by a concrete sea-wall. This wall was built in mass concrete, lightly reinforced with steel. Its position was such that during high tide it was not touched by the water. It was considered possible to use concrete in mass instead of facing the wall with blocks. No difficulty was experienced in building this wall, as the cliff wall was sufficiently protected from the waves by the bank of chalk thrown out from the foundation excavation. Although successful here, this method is not generally to be recommended, since the risk of injury from storms is too great. A facing of concrete block is advisable, as it provides a hard face immediately the wall is built for the seas to strike against and also gives protection to the work during construction. In order to provide against attrition by shingle, the wall was faced with flint 46 in. in diameter embedded in the concrete. These large flints were not easily broken by the impact of other stones driven against them by the sea, and provided a face which withstood the attrition well.

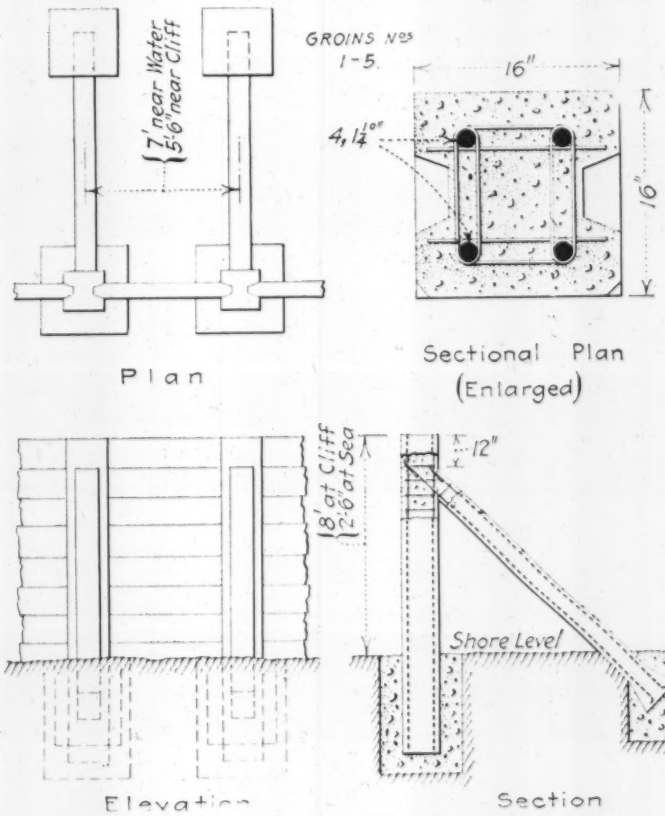

Fig. 2. Details of Groins 1 to 5

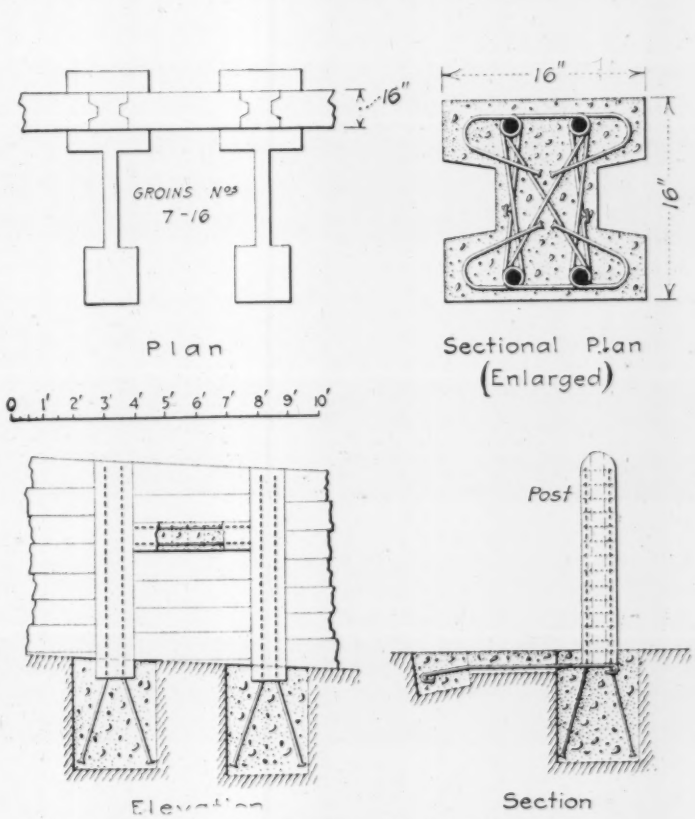

Fig. 3. Details of Groins 7 to 16

Later Construction

The groins which were built later from 1909 to 1911 are shown in detail in Fig. 3. For each of these, it will be noted from Fig. 1, a wall was built as an additional protection. The groins were similar to those already described, but embodied certain important differences in detail. They were built approximately at right angles to the shore line, or 500 ft. long and 500 ft. apart. As it was anticipated that shingle would quickly collect on the west side of the groins, but would be slower to collect on the east side, the walls referred to were erected in length of about 200 ft. immediately to the east of each groin. Thus it was hoped that protection would be given to the most vulnerable part of the coast line while the shingle and sand collected. The wisdom for this procedure had been amply proved by experience.

As a result of the experiences with the earlier work, the landward part of each groin for about 120 ft. from the cliff was so designed that all irregularities on the face were avoided. The slabs were all made 16 in. instead of 6 in. thick, thus bringing their surfaces flush with those of the 16-in. column. The tops of the groins were finished smooth and rounded and present unbroken lines, instead of columns projecting above the slabs. Struts were abandoned and the columns were sunk deeper into the chalk and provided with a system of tie-rods on the windward side. These tie-rods, shown in Fig. 3, although not in the most effective position for holding up the column, were put in owing to the possibility of scour taking place on the lee side of the groin. The absence of the projections on the groins not only obviated injury from the grinding action of shingle, but also diminished the disturbance of the water, and there-

fore promoted conditions more favorable to the deposition of shingle.

The columns and slab forming the heavy, smooth part were made entirely of granite concrete of the kind which showed up well in the repairs on the first work. The construction was practically the same as in the other form, that is, the columns and slabs were molded separately and tied together with grout and rod.

As the sea-wall was to be subjected to the attack of the ocean, a separately-molded block face was adopted. These concrete blocks were molded on shore and placed in the wall, tied back into a concrete revetment laid up against the cliff.

The groins here filled up rapidly on the windward side near the toe of the cliff, chiefly with coarse shingle and flint. During the summer of 1911 when all the groins were complete, sand began to collect over a large area of the foreshore which before consisted principally of bare chalk. The quantity of shingle or sand moving along the foreshore at this part is comparatively small, but a very considerable quantity of both sand and shingle had already been collected.

The authors state that the problem here is somewhat different than it would be if it were a pure sand shore. Their arguments follow:

The problems connected with erosion are here quite different from those in the case of sandy or shingly foreshores. In the latter case the material moves about under the influence of tides and waves, eroding here, accreting there, but on the whole remaining on the foreshore. When chalk is removed by the sea, however, it disappears, the particles being so fine that they are carried away by the currents and entirely lost to the shore. The only product of the disintegration of such chalk cliffs or foreshores which is of any value as a protection against the sea is the flints. The chalk contains about 10 or 12% of flints in the form of irregularly and often grotesquely shaped boulders, and in flat sheets. These remain on the foreshore after the chalk is finally broken up by the waves and washed away. While affording protection to the toe of the cliff, a bank of flint shingle, which contains on this coast a fair proportion of stones 3 to 6 in. in diameter, is a very effective disintegrating agent, when the flints are dashed against the cliff or foreshore by the waves.

On a sandy or shingly shore, when the erection of groins has to be considered, not only must the probable benefit due to accumulation on the windward side of the groins be taken into account, but also the possible injury resulting from stoppage of the littoral drift, which shows itself as depletion on the leeward side of the groins, must be kept in view. On a shore where there is practically no loose material, this question of erosion at the leeside is not of such importance, and groins may, with advantage, be constructed higher than on a sandy shore. When the cliff is protected by a shingle bank from actual contact with the waves, erosion is checked; for not only is the undermining action stopped, but also the lowering of the foreshore level, since the chalk is protected by the overlying shingle. This flint shingle appears to wear very slowly, being reduced in size not by a simple grinding action, but by chipping and grinding combined. It offers, however, great resistance to abrasion. This peculiarity of flint shingle renders it an unsuitable material for concrete which is exposed to severe blows, since the surface pebbles are splintered and removed.

Conclusions

The authors give the following conclusions as to the design in general of concrete sea-defence work:

Consideration of the works here described, and of the difficulties met with, points to certain important principles in connection with the design of concrete sea-defenses, which may be briefly summarized as follows:

A smooth surface, free from projections, should be given to groins and sea-walls. Irregularities on the sides of a groin offer obstruction to the waves; the work is thus exposed to unnecessary stresses, deposition is hindered, and attrition of the groin surface is increased. Struts or ties, being open to the same objections, should be avoided where it is not possible to bury them entirely below the surface.

A tough stone should be used for the surface of concrete groins exposed to attrition shingle. Flint-shingle is unsuitable except for parts of the groin which run through sand or are below the surface.

Where it is possible to avoid it, concrete work on the foreshore, except in foundations, should not be put in in situ, but should be molded in the form required and well seasoned before being placed in position. It is difficult to prevent injury to the fresh concrete before it has properly set. This does not apply, of course, to concrete mass work in sea-walls, which are protected on the face by seasoned blocks.

All concrete should be made non-porous by carefully proportioning the ingredients and well ramming. Ordinary rounded shingle contains up to 40% of voids; it is, therefore, desirable to provide about 50% of sand, both shingle and sand being composed of ungraded particles of as great a variety of sizes as possible.

Steel used for reinforcing should be embedded more deeply than for land work. This allows for displacement in construction, for the action of salt water where the concrete covering is not quite impervious, and for abrasion or wearing away of the surface by the attrition of shingle.

A Japanese Engineering College

The Imperial University of Tokyo comprises six colleges, of law, medicine, engineering, literature, science and agriculture. The University as it exists at present was organized on Mar. 1, 1886, by an Imperial Decree consolidating the two former institutions, the University of Tokyo and the Imperial University; and it is maintained chiefly by government appropriations. The faculties of the various colleges are composed almost exclusively of Japanese; in the college of engineering but one chair is held by a foreigner, the professor of naval architecture, who is Frank P. Purvis, M. Inst. C. E.

There are a number of interesting features connected with the courses and work of the University, which are described in a recent catalog, from which we have made a number of brief abstracts.

Officers—The officers of the University are as follows: President, Secretaries, Business Manager, Superintendent of Students, Librarian, Clerks and Library Assistants. The two Secretaries have charge of all matters relating to the administration and to the treasury of the University; the Business Manager is subordinate to the Secretaries and his title sufficiently explains the nature of his duties; the two Superintendents of Students correspond somewhat to Proctors in American universities. The faculty of the university consists of 156 professors, 66 assistant professors and 132 assistants.

Degrees—The degree granted to graduates of the University is that of *Hakushi,* of which there are nine varieties, corresponding to the different courses of study. The degree is conferred by the Imperial Minister of Education on (1) persons who have passed the prescribed examinations, or "on those who, having applied for the degree by producing a thesis on any subject in connection with their special branch of study, shall be considered at a faculty meeting of one of the colleges to possess attainments equal to or higher than those necessary for passing the said examinations"; (2) those who are considered at one of the *Hakushi* assemblies to possess the requisite attainments for the degree of *Hakushi.*

There are nine varieties of *Hakushi* assemblies, corresponding to the different varieties of that degree. These assemblies are called by the Minister of Education whenever he deems necessary, or on demand of the chairman of the assembly. Each assembly consists of all the hold-

ers of the particular kind of that degree which it represents. Half the members are necessary for a quorum.

If the holder of a degree be found guilty of any conduct detrimental to its honor, he may be deprived of his degree by the Minister of Education in accordance with a resolution passed by a *Hakushi* assembly. A resolution granting a degree requires a majority of not less than two-thirds of the members present; and the forfeiture of a degree requires a three-fourths majority of the members present, voting by ballot.

SCHOOL YEAR—The academic year begins on Sept. 11 and ends July 10, and is divided into three terms. There is a two weeks' vacation at the end of the first term, a week at the end of the second term, and the summer vacation is just two months. Lectures are suspended only on Sundays and holidays.

STUDENT REGULATIONS—When a student is admitted to any one of the colleges he is required to take a prescribed oath. A student desirous of leaving college must present a written application to that effect, signed by himself and one of his sureties. A student who is distinguished for his scholastic attainments and good morals may be made an honor student; such honor students enjoy the privilege of exemption from tuition fees, but by misconduct, idleness or illness they may be deprived of their honors.

ENGINEERING COURSES—The engineering college offers ten courses of three years each, as follows: (1) Civil Engineering; (2) Mechanical Engineering; (3) Naval Architecture; (4) Technology of Arms; (5) Electrical Engineering; (6) Architecture; (7) Applied Chemistry; (8) Technology of Explosives; (9) Mining; (10) Metallurgy.

The course in Civil Engineering is as follows:

CIVIL ENGINEERING

First year

	Hours per week 1st term	2d term	3d term
Mathematics	3	3	
Applied mechanics	6	2	3
Outlines of heat engine	1	1	1
Building materials	3		
Mechanical and metallurgical technolgy	2	3	
Geology			2
Masonry		5	2
Hydraulics		1	2
Bridges			4
Road-making		1	2
Surveying	2	2	
Design, drawing, and practice	19	18	20

Second year

Hydraulic engineering	2	4	5
Railways	3	3	3
Bridges	4	4	
Sanitary engineering	4½	3	3
Masonry			3
Outline of electrical engineering	2	2	
Workshop appliances	1	2	
Industrial economy		1½	1½
Design and drawing	19	17	21
Practical exercises			

Third year

Hydraulic engineering	2		
Street railways	2		
Masonry	2		
Hydraulic machinery	1½		
Seismology	2	3	
Administrative law affecting engineering works	3		
Building construction	2	2	
Geodesy	2	2	
Design and drawing	20	29	
Practical exercises			
Graduation design			

STUDENTS' STANDING—The yearly mark a student receives in any subject is determined by the average of his term marks in that subject; and in determining a student's average for an academic year, the year mark in each subject is multiplied by a coefficient appropriated to that subject according to its relative importance, and the sum of the products is divided by the sum of the coefficients. A student is passed when his general average mark is above 60 and his year work in every subject above 50. One who fails to pass is required to attend all the classes which he attended the previous year. At the end of each academic year lists of the students showing these general average marks are issued.

PRACTICAL TRAINING—Practical work may be done either at the college or outside. Students at practical work in college are always guided by instructors, and if they undertake any practical work outside the college, or make excursions to inspect outside establishments by themselves, they are furnished beforehand with detailed instructions or directions in writing. Students undertaking practical work or excursions are required to submit a written report of their work, unless such work is done with an instructor. Special examinations are held to test the knowledge gained in practical work.

Students in practical, outside work or on excursions are particularly warned to do nothing derogatory to the honor of students of the University; and while on such tours are forbidden to remain in any other place than their destination; should a student be obliged to do so on account of illness or circumstances beyond his control, he is required to produce a medical certificate in case of illness, or a certificate from the local office of the city, town, or village showing cause for his being there. While engaged in practical work, whether in the college or without, the students are compelled to wear their university uniforms. Students are not allowed to do anything except what they have been directed to do in the way of practical work, but if a student is obliged by circumstances to alter any point in the directions given him, he may submit the matter to the instructor for consideration and approval.

MUSEUMS—Among the interesting features of the University are the eight museums devoted to specimens, models, instruments, etc., necessary to illustrate work in each course of study. The museum of civil engineering comprises a collection of models of railways, bridges, canals, ports, water-works, drainage-works, etc., 164 models in all. In the mechanical engineering museum are various machines and models of machines, instruments, steam engines, samples of test pieces, etc., in all 1800 exhibits. The museum of naval architecture contains models to the number of 1230. There are also museums of arms, electrical engineering, architecture, chemistry, mining and metallurgy.

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A State Highway Law, just enacted in West Virginia, combines the offices of state highway engineer and professor of highway engineering in the State University. We quote from the act as follows:

Sec. 1. There is hereby established a state road bureau. It shall consist of the following persons: The professor in charge of the railway and highway department at the state university for the time being, who shall be the chief road engineer and the chairman of the road bureau; the director of the experimental station at the state university for the time being and two additional members of said bureau, who shall be qualified voters of the state, and shall be appointed by the governor. The said two additional members shall not be both appointed from the same political party.

Sec. 2. The governor shall appoint some qualified and experienced civil engineer to be the professor in charge of the railway and highway department at the state university.

Sec. 3. The said chief road engineer shall receive an annual salary of $3500. The two additional members of the said bureau shall each receive out of the state treasury $10 per day for so many days, not exceeding 90 days in any one year, as he may be employed in the duties of his office, and his actual expenses incurred in the discharge of his duties.

Sec. 4. It shall be the duty of the state road bureau to supervise and to furnish information as to the location, construction and maintenance of all public roads in this state, to provide for giving instruction in road building and to supervise such instruction, and render assistance to the county road authority.

A Notable Reservoir for Flood Control in Germany

By Kenneth C. Grant*

The largest dam in Europe has just been completed on the Bober River, a tributary of the Oder, in the province of Silesia, in southeastern Germany. It has been built by the Prussian Government and the province of Silesia for the purpose of controlling floods and developing water power.

The Bober rises in the Riesengebirge ("Giant mountains"), which form the boundary between Bohemia and Silesia, and flows northward through a beautiful hilly country, emptying into the Oder a short distance below Crossen. Its drainage basin receives a heavy rainfall, particularly in the upper portions, and its valley has frequently been visited by disastrous floods. The greatest of these floods, that of July, 1897, was the cause of the construction of this dam. The capacity of the reservoir is great enough to impound the damaging part of the flood water, only the discharge that the channel below the dam can carry without overflow being allowed to pass through the gates during a flood. It is also great enough so that the reservoir can be kept about half full and the water thus stored used for the generation of electric power at a large powerhouse immediately below the dam, as well as for the increase of the flow of the lower Bober, a great benefit to the power plants along its course.

The dam is located about 6.2 miles below the town of Hirschberg, and about 1¼ miles above the village of Mauer. At this point, the Bober makes a wide reverse curve, and the sides of the valley draw close together, with steep, rocky walls over 300 ft. high, forming a site apparently designed by nature for the erection of a large dam.

The drainage area above the dam is 467 square miles. The maximum recorded discharge from this area, which occurred in July, 1897, amounted to 42,360 sec.-ft., or 91 sec.-ft. per square mile. The minimum discharge is about 53 sec.-ft., or 0.11 sec.-ft. per square mile.

The total capacity of the reservoir is 1,765,000,000 cu.ft. When the reservoir is full, the surface area is 593 acres, the greatest water depth is 153 ft., and the length is 5¼ miles.

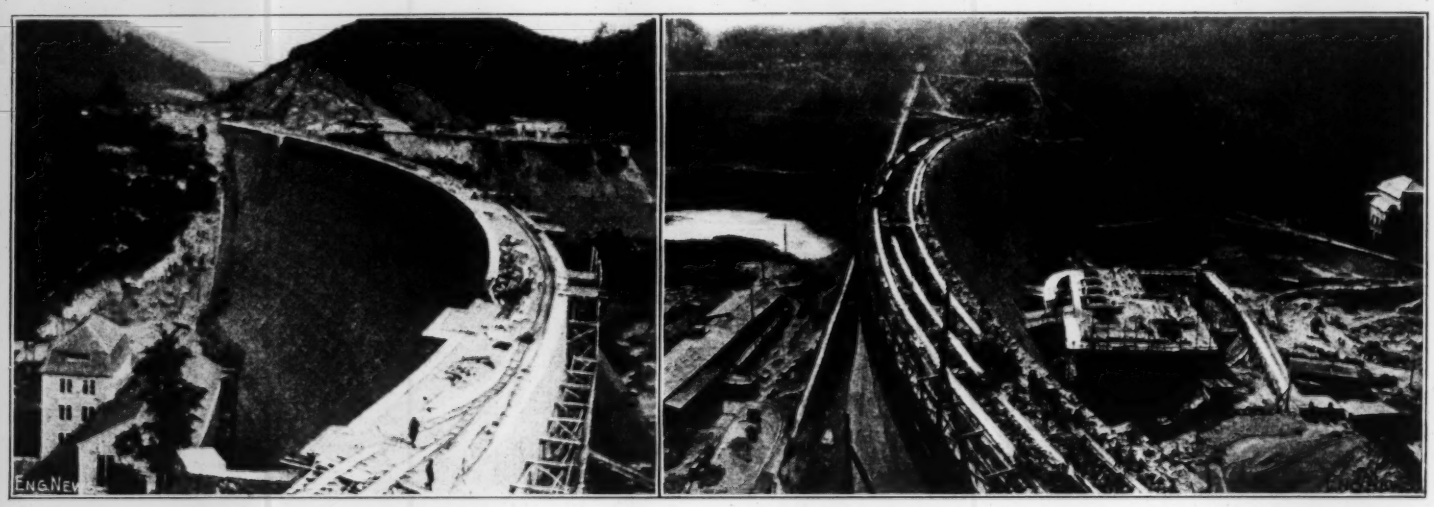
*Consulting Engineer, Arrott Bldg., Pittsburgh, Penn.

The dam is 203 ft. high, 23.6 ft. wide on top, and 165 ft. wide at the base; in plan it is curved upstream, with a radius of 820 ft. A roadway runs along its crest, which is 918 ft. long. It is built of stone masonry, of which it contains 332,000 cu.yd. The total excavation for the dam amounted to 222,000 cu.yd.. A mortar composed of 1 part cement, ½ trass, ⅓ lime and 5 sand was used. The stone was quarried in the valley about 2½ miles above the dam site. The sand was obtained from the valley directly below the dam. The other materials and equipment were brought to the site over a railroad line constructed for this purpose.

The material was distributed on the work by means of hand-cars operating on tracks on top of the dam. A long inclined trestle on the upstream side of the dam brought the cars up to the level of the work by means of cable haulage, after which they were pushed by hand. No overhead cableway was used during construction, the curved form of the dam not being adapted to this method of bringing material to the work.

During construction, the water of the Bober was deflected by a diversion weir 30 ft. high, built about 900 ft. above the site, and was passed around the work through a tunnel 1255 ft. long, 29.5 ft. wide and 23 ft. high, driven through the solid rock on the right side of the valley. A second low dam, just above the outlet of this tunnel, and about 460 ft. below the site, prevented the water discharged through the tunnel from backing up and overflowing the work. The tunnel had a discharging capacity of 10,590 sec-ft., or only about ¼ the maximum discharge of the Bober. As a result, the work was several times delayed by overflow of the site.

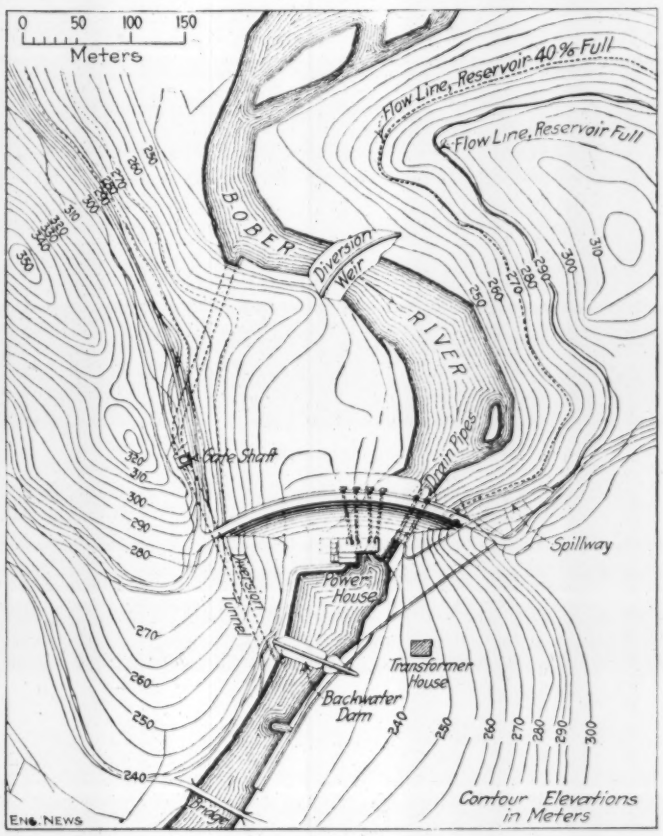
After the completion of the dam a section near the middle of the diversion tunnel was walled up and three 5-ft. discharge pipes were built into this bulkhead. These pipes are provided with double sliding gates, which are operated by spindles extending up through a vertical shaft to a gate-house above high-water level in the reservoir. Near the left end of the dam, two other discharge pipes of the same size pass through the dam at the bottom of the reservoir; these are provided with gates on both the upstream and downstream sides of the dam. When the reservoir is full, the five pipes can discharge 8825 sec.-ft., which is the amount the channel of the



Figs. 1 and 2. The Bober River Dam at Mauer, Germany, near Completion

Bober below the dam can carry without overflow. This discharging capacity is in addition to the amount that passes through the four 64-in. penstocks of the turbines.

At the left end of the dam there is a spillway 285 ft. long extending along the side hill, with its crest 5.9 ft. below the crest of the dam. Water passing over this spillway flows under an arch at the dam and between guiding walls down to the river bed below the backwater dam over a cascade on the rocky side of the valley, which has been cleared of all soil and loose material. The discharge over this spillway in the event of the water rising to the crest of the dam would be 17,650 sec.-ft., and at this level the reservoir capacity would be increased by 158,850,000 cu.ft. Such a condition can never arise, however, as extended records of the flow of the Bober show that its floods are not of long duration. By the time the



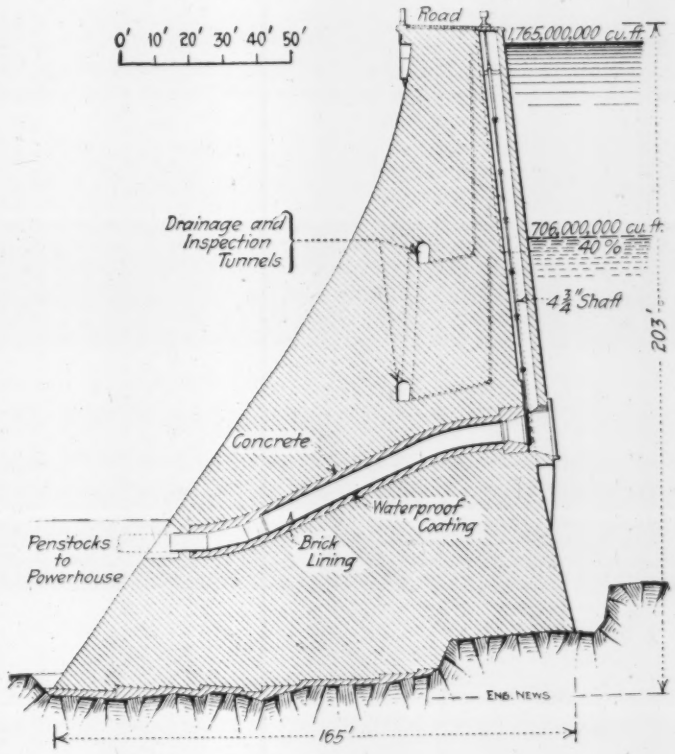


FIG. 3. LOCATION PLAN AND MAXIMUM CROSS-SECTION OF MAUER DAM

reservoir has filled, the maximum rate of flow, or peak discharge of the flood, will have passed, and the discharging apparatus above described will be ample to accommodate the flood discharge that may still remain.

The powerhouse is located immediately below the dam. The water is brought to the turbines through four circular concrete brick-lined tubes, 5¼ ft. in diameter, provided with gates on the upstream side. There are 4 units of 1500 hp. each (rated at average water level in the reservoir) or 6000 hp. in all. With the reservoir 60% full, 8000 hp. can be developed. In years of normal rainfall the power is reckoned as 3600 hp., 24-hr. power, with 89 ft. head.

This power is operated in connection with that developed at the Marklissa dam, a similar structure about 17 miles to the west, completed in 1905, on the Queiss, a tributary of the Bober. The Marklissa plant has 3000 hp. maximum capacity, and 1500 hp. average. The power from the Marklissa plant is brought to a transformer station at the Mauer dam at 30,000 volts, and there stepped down to 10,000 volts. The combined power from the two dams is then distributed over a wide area of the surrounding country. About 154 villages and 14 towns are thus supplied, at a price of from 2 to 4c. per kilowatt-hour.

About 60% of the total capacity of the reservoir, or 1,059,000,000 cu.ft., will be used for power purposes, and kept as full as possible. The remaining 706,000,000 cu.-ft. of capacity will be kept empty for flood control. It was at first planned to keep 60% of the capacity empty for flood-control purposes, but the successful experience of 8 years in manipulating the Marklissa reservoir for combined purposes of flood control and power development, and careful studies of the flow of the Bober River, have proved that it will be sufficient to keep only 40% of the capacity empty for flood control. In the original designs an overflow weir discharging through a downfall shaft into the tunnel at the right of the dam was proposed. This shaft would have emptied into the tunnel below the bulkhead containing the discharge pipes already described. The spillway would have been placed at the level at which the reservoir has a capacity of 706,000,000 cu. ft., or 40% of the total capacity. Discharge over its crest would therefore have commenced as soon as the flood-control capacity at first contemplated, or 60%, began to be encroached upon. The weir was to be controlled by gates in such a manner that the discharge by this outlet would never exceed the carrying capacity of the river channel below the dam, or 8825 sec.-ft. This device would have served the double purpose of keeping the river within its banks below the dam, and of reserving the 60% flood capacity of the reservoir for the storage of damaging flood water only.

As already stated, however, the successful experience with the Marklissa Dam, and the studies of the Bober's flow, showed this part of the plan to be unnecessary; for

it was found that the floods were of short enough duration so that by the time the reservoir might fill up, the rate of flood discharge would have fallen to an amount that could be taken care of by the other discharging apparatus already described. The saving in cost and the increase in power output that have been obtained by this important change of the plans are a striking example of the necessity of having adequate stream-flow records in

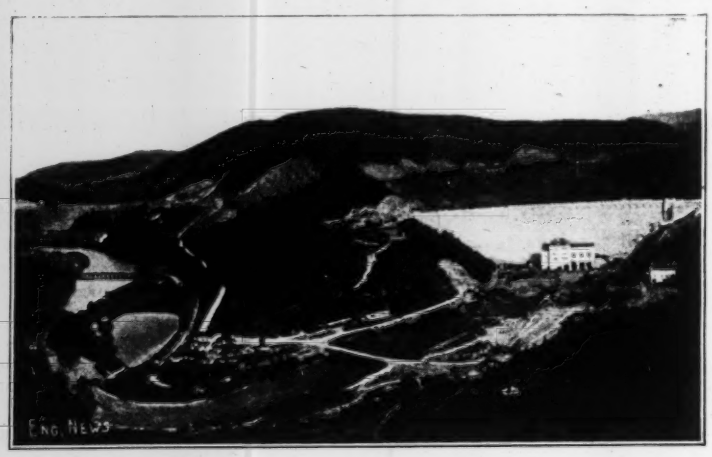


FIG. 4. THE BEND OF THE BOBER, BELOW THE MAUER DAM

order to design a reservoir of this character safely and economically, and in such a way as to get the greatest possible use of the water stored.

The cost of the dam and appurtenances was $1,416,000, and of land and damages, $576,000; making a total cost of $1,992,000, or about $1130 per million cubic feet of storage. The flooded area in general was not built up, but the damages were raised to the above high

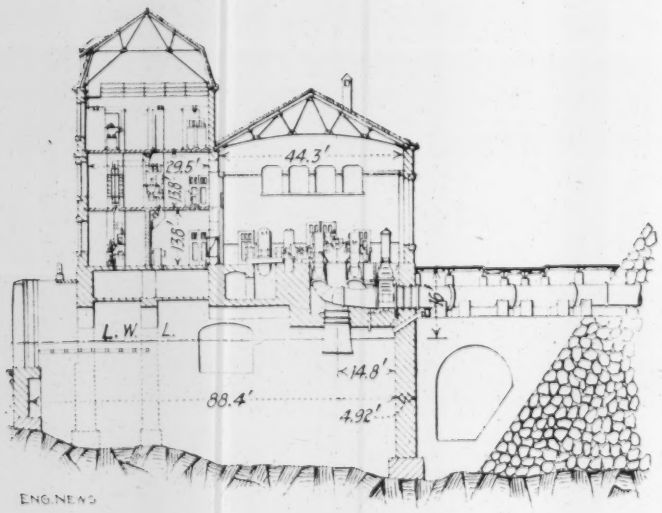


FIG. 5. CORSS-SECTION OF POWER HOUSE BELOW MAUER DAM

figure by the fact that a large paper mill and a pulp mill had to be bought.

Of the above cost of $1,992,000, the state of Prussia bore four-fifths and the province of Silesia one-fifth. In addition to this, however, the province of Silesia has also appropriated about $1,968,000 for the power plants at Marklissa and Mauer and for the transmission lines. Further, the province has paid the state about $480,000 for the water rights at the reservoir site.

The first work on the reservoir was begun in 1902. Land was bought and the investigations of the footings at the dam site were carried out. The latter were not completed until 1903, being attended with considerable difficulty, on account of the bed of the valley being filled with sand, gravel, boulders and other water-worn drift. In 1904 the diversion tunnel was begun; it was completed in 1905. The excavation for the dam was carried out in 1906 and 1907. Work on the dam itself was begun in 1908, and in June of that year the cornerstone was laid with great ceremony. When the work was in full progress about 250 masons and 550 laborers were employed. The maximum amount of masonry placed per day was about 1000 cu.yd.

The dam was finally completed in Nov., 1912. On Nov. 16, it was formally opened by the Emperor with great ceremony in the presence of a distinguished body of statesmen and engineers.

Reminiscenc of a Pioneer Engineer of the Great Northern Ry.

(CONTRIBUTED)

The present style of lettering maps and plans came into vogue in the '90's, and it gradually superseded the more elaborate style of earlier times. Map draftsmen, who were expert letterers, were none too common in the early days and they received better salaries thirty years ago than are paid today. Roman and script texts were the standards, and much time was devoted to designing artistic map titles. The Roman letter, extremely flexible, lent itself to an endless variety in composition. In a well executed title, each letter was proportioned to the place it occupied and no mechanically set dimensions were tolerated by the best draftsmen.

Good script writers were more rare than masters of the Roman type. The necessary firm but delicate touch, the result in some cases of years of practice, was not to be attained to perfection by the common run of draftsmen. In still earlier times the bold flourish and fancifully decorated letters were commonly used.

The accompanying sample is from the pen of one of those early experts, a hasty title executed offhand by a man several years past three score and ten, but who was still active in the closing years of a busy life in the drafting room of the great railway system which he once served for twelve years as Chief Engineer. This man, Charles A. F. Morris, was a type of a group of hardy pioneer engineers, now fast disappearing.

Charles A. F. Morris had taken his degree at Trinity College, Dublin, Ireland; he had served a three years' apprenticeship under a prominent British civil engineer, and spent two years in the government service on railroad, bridge, highway and seawall construction. He had become apt in organization and in the direction of large forces of men before reaching his majority.

He married and emigrated to America. Immediately after his arrival in New York City he entered the employ of the Hudson River R.R. Co. and spent five years on railroad location and construction on various Eastern railways.

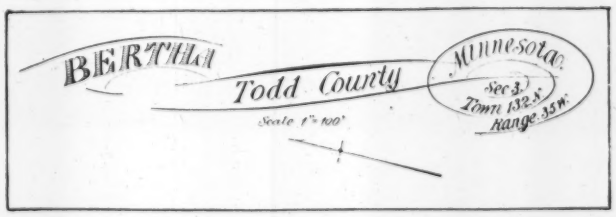
He then decided to take a hand in the development of the Northwest. Within a year of his arrival in St. Paul, Minn., in 1854, he secured a large tract of land on Lake Minnetonka and erected a steam sawmill at St. Al-

bans Bay. For one full season he supplied the demand for oak lumber of a territory within a radius of some hundred miles. The next year the mill was burned and $40,000 went up in smoke with no insurance.

Thus forcibly switched back to his old profession, he associated himself with the men who organized the Minnesota & Pacific R.R. Co. As promoter, engineer and contractor, he followed the misfortunes of this first railroad enterprise of Minnesota for three futile years, when the property reverted to the state. Hundreds of miles of line had been located north, south and west of St. Paul, and 60 miles of grading were completed on the east side of the Mississippi River, but 1400 ft. was the sum total of track laid.

The St. Paul pioneers, however, were not the men to let go of a good thing at the behest of adversity. Two years later the company was reorganized as the St. Paul & Pacific R.R. Co. Ten miles of track between St. Paul and Minneapolis were laid on the roadbed already graded and the locomotive, "Wm. Crooks, No. 1," was put into commission. A few months ago, on the occasion of James J. Hill's 74th birthday, the old "Wm. Crooks" was again put under steam at the St. Paul Union Depot.

During the year of reorganization of the railway, Mr. Morris served a term as City Surveyor of St. Paul. In 1863-'4 he graded under contract the Winona branch of the St. Paul & Pacific R.R. from St. Paul to Hastings. Later he was employed in various capacities under Chief



SAMPLE OF AN OLD-STYLE SCRIPT TITLE
(One-third actual size.)

Engineer James D. Skinner, whom he succeeded in 1868. In 1867 he had bridged the Mississippi for the city of St. Cloud. During the greater part of his service as Chief Engineer the St. Paul & Pacific was in the hands of a Receiver.

When Mr. Morris became Chief Engineer of the St. Paul & Pacific in 1868, the road had been completed only from St. Paul to St. Cloud, 75 miles up the Mississippi River. In 1879 the St. Paul, Minneapolis & Manitoba R.R. Co. was organized by James J. Hill and his associates for the purchase of the St. Paul & Pacific. The Dutch bondholders were glad to turn over the wearisome burden of their holdings to the new company. About 600 miles of track and a land grant of two and a half million acres were secured for about $6,000,000.

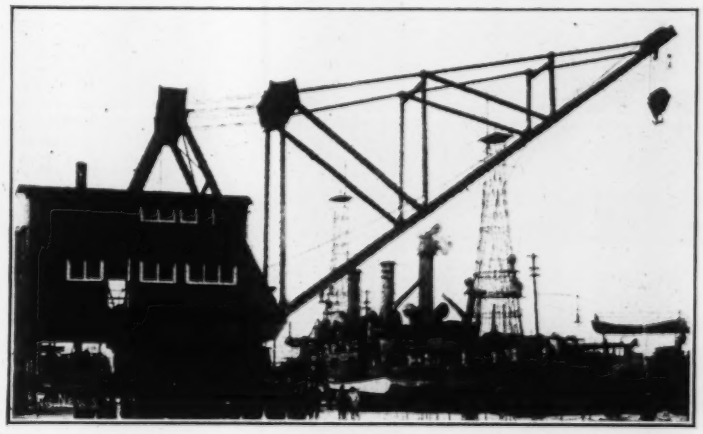
Mr. Morris resigned a year later to take charge of the construction of the Oregon & California R.R. from Portland, Ore., south. When this work was completed, about five years later, he took a little vacation in Paris before becoming the Chief Engineer of the St. Paul & Duluth R.R. He now began to think about settling down to a quiet life, and he built himself a home on Lake Minnetonka, not far from the site of his early misfortune.

But his time was not altogether devoted to rural enjoyment. After six years on the St. Paul & Duluth he was chosen Building Inspector of the city of St. Paul for the term 1892-'3. He then retired. Naturally this did not suit a man of his active temperament. At the age of 71 he returned to the service of the great railway system whose early development he had so well directed. At the age of 75 years he could still be found in the drafting room where his hand was still steady, and his touch firm. Mr. Morris was a stocky, round-faced little man, much below medium height, impulsive and quick of speech, but much beloved by his associates. He died in 1906 in his 79th year.

A 50-Ton Locomotive Crane*

A 50-ton locomotive jib crane has been ordered by the U. S. Navy Department for the Brooklyn Yard, from the Browning Engineering Co., of Cleveland, O. When completed it will probably be the largest locomotive crane in the country. The design will be similar, except for the boom, to the 40-ton type shown in the accompanying figure, built by the same company for the Navy Yards at Portsmouth, N. H. and Norfolk, Va.

The 50-ton crane will have that gross lifting capacity at 70 ft. radius; at 85 ft. the capacity will be 40 tons and at 123 ft. (the maximum radius) 15 tons. The main boom will carry a counterweighted auxiliary end boom



A 40-TON LOCOMOTIVE JIB CRANE
(As built by the Browning Engineering Co., for the U. S. Navy Yards at Portsmouth, N. H., and Norfolk, Va.)

with its control machinery on the body of the crane. The main-boom hoist will have 1-in. steel cable (30 parts) with both ends wound on 24-in. drums.

The estimated weight of this machine is 500 tons. There will be 16 rolled-steel, double-flange 30-in. wheels, keyed to the axles; the wheel base will be 29 ft. 9 in. and the track gage 18 ft. A track speed of 120 ft. per min. will be secured.

The particular service for which this crane is needed is reported to be in handling the wire-cage type of military mast. Heretofore it has been necessary to remove these in two or three sections during overhauling. The crane track will run around one end and both sides of the dry dock for general service in lifting boilers, machinery, armor plate and ordnance.

Panama Canal Excavation during February, totaled 2,108,530 cu.yd., a daily average of 91,675 cu.yd. for each of the 23 working days. The rainfall was 1.09 in. The amount of concrete laid in February was 77,489 cu.yd., and 123,792 cu.yd. of fill was placed in dams.

*From information furnished by the Browning Engineering Co., Cleveland, Ohio.

A Bill to Provide for State Water Conservation and State Control of Dams in Pennsylvania

For a number of years past there has been in existence in Pennsylvania a State Water Supply Commission, consisting of five members. The powers of the commission have not been very extensive. They have included the passing upon applications of water company charters and limited control over the building of dams or other obstructions in navigable streams. There is now pending before the Pennsylvania Legislature a bill which, if enacted, would create a State Water Commission with powers much larger than those of the present commission and at the same time consolidate earlier legislation for water control.

The feature of the proposed legislation that is of most interest to engineers is the proposal to subject the location, design, and construction of dams and all other stream obstructions to the control of the State Water Commission. Other notable features of the bill are its provision for what might be termed a water conservation survey of the whole state; the surrender to the state of all unused water and dam site rights; the control over the chartering, consolidation and lease of water-supply and water-power companies; compensation for water or water-power improvements under certain conditions; and in general state control, through the commission (in some cases in conjunction with the governor), of the water resources of the state and their utilization for various purposes.

Like the present State Water Supply Commission, the new commission would consist of five members, including three to be appointed by the governor subject to the confirmation of the Senate and two members ex-officio. The ex-officio members would be the Commissioners of Health and of Forestry. The new bill provides that the three members appointed by the governor would serve four years with salaries of $5,000 per year, while the ex-officio members would be paid their necessary expenses only. The commission would be authorized to appoint a chief engineer, who would have to be "a competent civil and hydraulic engineer," at a salary of $5000 per year, and three principal assistant engineers, of whom one would receive $3000, one $2400, and one $1800 per year. Authority is also given for employing other engineers, geologists, clerks and field assistants.

The objects of the bill and its provision for a water conservation survey of the state are as follows:

Sect. 5. The intent and purpose of this act is to provide a method and powers for a full and complete investigation, survey, conservation, development, utilization and distribution of the water resources of the State in such a way as to make them of the greatest possible use to the largest number of people for the longest possible time and each provision of this act is to be interpreted in the most liberal manner for the best accomplishment of this purpose. The jurisdiction of the State Water Commission shall extend over and include all streams situate, lying and being wholly within this State or between this and any other State or States, including the river Delaware and all lakes, ponds or bodies of water either wholly or partly within this State, and over the use of the waters thereof as herein set forth.

Sect. 6. In order to carry out the provisions of this act it shall be the duty of the commission to procure as speedily and thoroughly as possible all data and facts and collect, tabulate, record and preserve in files and publish complete information concerning the water resources of the State, taking an inventory stream by stream and district by district of the amount of flow and present utilization thereof, to the end that a comprehensive plan may be eventually adopted covering the entire State, together with such recommendations as will best conserve, utilize, develop and distribute the waters thereof and so regulate the flow of the streams as to reduce floods in times of high water and provide increased flow in times of drought.

A number of comprehensive sections are included in the bill, each and all designed to make necessary the approval of the commission and also by the governor of the state of any charter which authorizes the "supply, storage and transportation of water and water power for commercial and manufacturing purposes." The approval of the commission and of the governor is also necessary for the consolidation of existing companies created for the purposes just named, or for the sale, assignment or transfer or lease of any franchise or real or personal property used for water-supply or water-power purposes. All these sections state with particularity that necessary applications to the end just stated should specify the "point or points on said streams or other bodies of water at which it is proposed to take or use water or water-power thereafter." Provision is made for the reversion to the state of the unused water rights of existing companies which apply for further powers.

All municipalities and private corporations desiring new or additional sources of water-supply for water or power must apply to the State Water Commission for the authorization before such sources can be utilized. Permits may be granted only on approval by a majority of the members of the State Water Commission, and also the approval of the governor. When such permits are granted they must be duly recorded with the secretary of state and the record must stipulate just what rights have been granted.

The sections of the act designed to give the State Water Commission full control over the construction of dams and reservoirs or any other obstructions to streams provide that "no persons or persons, corporations, states, counties, cities, borough or township officials shall have the right to build in or along any of the streams, lakes, or ponds" of the state "any dam, wall, wingwall, wharf, pier, embankment, abutment, projection, or other obstruction" or "cause to be deposited over the bank or in the channel of any such stream, lake, or pond any trades waste, municipal waste, ashes, or refuse of any kind, or material, nor make any addition to any existing dam," etc., "nor in any manner change or diminish the course, current, or cross-section" of any stream, lake, or pond without a permit of the State Water Commission, which permit shall contain "such restrictions, limitations, or other provisions as the commission may deem necessary or advisable." Applications for such permits must be accompanied by full plans and descriptive matter.

The bill provides for supervision and control of the construction of dams and reservoirs for which permits have been granted by the State Water Commission. The commission may require such changes and modifications in the plans as "may be necessary to conform to public policy and to insure public safety." To this end the commission shall "cause frequent examinations and inspections to be made during the progress of construction and at any time thereafter during the period of operation" of any dams and reservoirs built under its permit.

Either on its own initiative or on complaint from any

citizen, the commission may at any time "direct its engineer or other persons selected by it to examine into the condition of any dam or structure referred to in this act constructed or controlled by any person, corporation, county, township or borough for the purpose of determining whether the same is properly constructed and safe, or whether it be in any way dangerous to the public safety." If the examination indicates that the dam or structure is unsafe, then the commission may order it altered as it sees fit but not until after an order and hearing. If such an order is not obeyed, then the Attorney-General shall be notified and take such action as is necessary "for the removal or abatement of said structure as a public nuisance or a menace, as may be authorized by law."

The bill also authorizes any borough or city to request the State Water Commission to "establish permanent harbor or shore lines along any stream, lake or other body of water lying within" its boundaries, and the commission is authorized to act upon such applications as it sees fit after making various investigations.

In order to cinch still tighter the control of the commission no corporation or municipality may exercise the right of eminent domain as regards the waters or lands of the state without a permit to that end granted by the commission after application and investigation by the commission.

The right to purchase any works or plants constructed by any private corporation under the bill being reviewed is reserved to the state and any of its municipalities, but the right cannot be exercised until the expiration of 50 years from the date of the grant or privilege. Provision for appraisal by arbitrators is made in the case of such purchases, with appeal to the courts.

Compensation to the state and municipality or any corporation is provided for in the bill in cases where "the construction of storage reservoirs improve, regulate, or control the flow of any stream directly or indirectly" in such a way that the "now use" of the stream "is benefited or enhanced by such improvements, regulation or control." The amount of compensation to be paid is to be determined by the commission.

The right of water or water-power companies to operate under their charter may be inquired into by the commission at any time, either on its own initiative or in response to a petition. Such an inquiry would "determine whether such company has commenced work upon its plant or completed the same within the time provided by the law." Unless this investigation showed that this was not the case, then the commission would have power to issue a decree "declaring the company defunct or certify the facts in the case to the Attorney-General with a request that he institute *quo warranto* proceedings against such corporation for the annulment and revocation of its charter."

An interesting provision of the bill designed in the interests of the conservation and full use of the natural waters of the state is as follows:

Sect. 20. All reservoirs hereafter built by any person, persons, corporations, State, counties, townships or boroughs for which permits shall be issued under the foregoing provisions of this act shall, if the State Water Commission deem it necessary, and so direct, be designed and constructed with adequate storage capacity over and above that needed for the storage, supply, transportation and power purposes of the applicant sufficient to store and hold peak-flood waters during periods of maximum flows and with adequate facilities for increasing the low water flow at such periods of the year in which this, in the opinion of said commission, shall be deemed advisable, and the State Water Commission shall have the right and is hereby given the power to determine from its investigations and knowledge what requirements shall be deemed advisable and to take all necessary steps to control such flood flows and regulate low water flows, and any violation of the orders of the commission in connection therewith shall constitute a misdemeanor punishable as hereinafter provided.

In order that the commission may be fully informed, the bill provides that all "persons, corporations, municipal or private, storing, supplying or transporting water or generating or transmitting power therefrom" shall by Jan. 31 of each year make a report to the commission covering the calendar year ending Dec. 31 previously." Such reports shall "include a statement of the character and conditions of all the works proposed and plants and structures used for the purpose under the permit granted by the commission under the authority of this act, and such other information and details as may be required by the rules of the State Water Commission."

Violations of the bill constitute misdemeanors and render persons convicted of the same liable to fines of from $100 to $1000, or imprisonment of not over a year, or both fine and imprisonment at the discretion of the court.

The Appraisal of Water-Works Properties*

By Douglas A. Graham†

Water works properties are appraised for three purposes —for purchase, for rate-making and for the issuing of securities.

There are four distinct methods which have been employed in the appraisal of water-works properties and which have been quite generally recognized by the courts and appraisal boards as giving an indication, at least, of the true value of a property.

First, and perhaps of least importance, is the method of estimating the value of a plant by means of the market value of its stocks and bonds. This method would, of course, not be applicable to a municipally owned plant, and the instances are rare, in the West at least, where a continuing and representative market for such securities can be said to exist. Furthermore, the value of securities is generally based on the earning power of the utility and where limited franchises and municipal control prevail, such a basis would render the estimate of little value.

Another method, also based on generalities, is what might be termed the commercial or comparative method. This involves a consideration of the value of the plant in question as compared to averages of the values of other plants in general and to the values of individual plants in which all conditions affecting value are known to be similar. This is the method most available to the ordinary business man and, when used intelligently, gives useful results. It must be used with caution, however, and without prejudice, as individual plants differ widely in characteristics and values.

Next in importance comes the "past cost" method. Where the data can be accurately obtained, the past cost undoubtedly furnishes an excellent and, in some respects, a fair measure of value. Unlike reproduction cost it involves no estimation of depreciation, but, to offset this, no credit is given for the appreciation of land, material and labor values. Its chief objection lies in the difficulty usually encountered in obtaining reliable audits of the construction accounts, as few water companies have kept their early books in sufficiently complete detail to permit an accurate separation to be made between construction and operation accounts. Its chief advantage is that past cost represents actual expenditures

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, at Urbana, Ill., March 11, 12, 1913.

†Principal Assistant Engineer for Dabney H. Maury, 1137 Monadnock Block, Chicago.

and, when the plant has been wisely managed according to the local laws and requirements, the actual cost would seem to give a very fair measure of the true value of the plant to the community.

Last, and in most general use because of its universal adaptability, is the "reproduction method." This is in keeping with our common methods of trade appraisal and, in the hands of skilled appraisers, it furnished a very excellent measure of value. This method involves the hypothetical construction, step by step, of an exactly similar comparative plant, the hypothesis being carried successively through all the stages of origination, construction, and business development which would be necessary in the actual construction of a water-works system. The structures, machinery, pipes and the general or overhead items are estimated at what it would reasonably cost to reproduce them at the existing normal prices of material, labor and money, and the reproduction costs are then reduced by the amounts of depreciation the plant has suffered from all causes. The reproduction method is not as simple in application as is commonly supposed. The ability of the appraiser must be precisely that required in actually planning and constructing a new plant. Though the estimator has before him full sized plans and specifications, in the form of the existing plant and a complete inventory of the details involved, yet there are many items, such as temporary structures and conditions of hazard, which must necessarily disappear from view upon the completion of the plant, yet which must be estimated and included in the total cost of the work.

This method has both advantages and disadvantages. It requires a detailed study of the conditions involved and a logical reason for each step or theory adopted. It, therefore, tends to eliminate guess work and the effect of prejudice as far as possible. On the other hand detailed estimates tend to lessen the probability of a broad consideration of the subject and to substantiate small errors in unit prices which, because they are many times multiplied in the total, may materially affect the final result.

The first step in the appraisal is the preparation of the inventory. Properly prepared the inventory is quite different from that ordinarily made by business houses, where the object is to list up and describe articles which have a recognized market value. It should be a complete record of the details of the plant and should give the history of the plant, the laws or ordinances which might affect value, the conditions which would be met with during reconstruction and lists of the materials involved in convenient form for use in making estimates. It should contain such drawings and photographs as may be necessary to fully explain and verify the quantities given. The cost of a thorough and complete inventory is never wasted for, besides greatly increasing the probabilities of a fair appraisal, it saves much valuable time when the actual estimates are undertaken. Furthermore a complete inventory is a great help in the intelligent financing and operation of a plant, by giving the managers an intimate knowledge of the property under their care.

The actual appraisal begins with the estimation of the time element. The time available is of almost equal importance with the cost of materials, as the cost of construction, lands, water rights, etc., increase when the time available for construction is limited, and the amount of the general costs, such as interest during construction and going value, decreases under the same conditions. It is essential therefore at the beginning that a careful program of construction and business development be planned, and that all values be estimated with the time element clearly in view.

The item of costs preliminary to construction comes next. In any new enterprise the general scheme must first be originated, and much preliminary engineering investigation and legal work accomplished, before construction can be begun. Such costs are generally grouped under one heading, and estimated according to the experience of the appraisers in such matters. Lands and other real estate are usually valued by local men, as few engineers would be sufficiently well versed in local land values.

Then follows the estimates of cost to reproduce the pumps, pipes and other physical parts of the plant. These items are estimated from the lists of material and labor involved, using what might be termed the "normal" prices of each class of work in the locality considered. In most instances the "normal price" will be the prevailing market price, as most materials entering into the construction of a water-works do not suffer appreciably from market fluctuations. In the case of some items, however, notably cast-iron pipe, the fluctuations, even in a single year, may be so rapid as to make it entirely unreasonable to adopt the price at any one moment.

For example, if it is desired to find the value of a plant for the purpose of fixing rates, it is the value of the plant for future service that must be considered. Should the price of materials be extremely high or unusually low at the moment, the resulting value would only be the value of the moment, and rates based upon such a value would be neither fair nor reasonable. It is obvious, therefore, that only by the use of an average or normal price can justice be done to both the city and the company.

After the construction estimates have been made there are certain general items which must be considered, namely Engineering, Legal, Administrative and Contingent costs, during the construction period, and the interest on the various expenditures until operation begins and the fixed charges can be carried to operating accounts. These items may be estimated in different ways and included either with the items of construction or in lump sums as separate items. They are just as much a part of the physical value of the plant as its buildings, machinery and pipes.

After the Reproduction cost of the Physical Property has been found the estimates must be reduced to present worth by the deduction of an amount which will represent the loss in value the plant has suffered by reason of its past service, and its possible inadaptability to the service which will be demanded of it in the future. If the appraisal is for rate-making purposes, depreciation must be considered in connection with the proper allowance to be made as fair return, as the Courts have held that a Public Utility is entitled to provide a fund which will keep its investment intact.

Water-works depreciation may properly be divided into three general divisions, viz.: Ordinary, Functional and Contingent Depreciation, the latter being considered only in operating accounts.

By Ordinary Depreciation is meant that decrease in the service value of a machine or structure which takes place by reason of ordinary wear and tear. The rate of loss in value from this form of depreciation increases as time goes on, being small at first and rising rapidly as the end of the life of the structure or machine approaches. Ordinary depreciation is very small in cast-iron pipe and in earth and masonry recervoirs, and large in machinery and most metal construction.

By Functional Depreciation is meant that decrease in value which comes from obsolescence, due to changes in conditions or in the art of construction, or to any things which make a structure or apparatus unsuitable for the service it is called upon to provide.

This form of depreciation is especially noticeable in machinery, which has become inefficient or inadequate, and in the distribution system when small mains must be replaced by larger ones, owing to the growth of the city, or where incrustation has reduced the original capacity of the pipes.

Contingent Depreciation is estimated only for use as an operating account, and does not affect the reproduction value of the plant. It is simply a device for spreading certain extraordinary expenses over a period of years. Such expenses occur in the operation of every plant and, when no special provision is made for them, they make it difficult to properly understand and provide for the ordinary expenses of operation. Examples of Contingent Depreciation are the costs involved in the bursting of mains with consequent damage to private property, electrolysis of mains, and the lowering of mains when street grades are changed.

After the appraisal of the plant has been carried to this point, there remains only the reproduction of the business and income of the plant. This is commonly termed the "Going Value" or "Going Concern Value" and its existence and the necessity of including it in a complete appraisal have been almost universally recognized by the Courts.

Many attempts have been made to find a simple method for estimating Going Value but with little success, and it may be said that there are but two methods in general use. One, the Reproduction method, involves a comparison of net incomes, either actual or estimated on the basis of fair rates, between the existing plant and the comparative hypothetical plant. The other, the Past Cost method, is based upon a computation of the deficits in operation and fixed charges during the entire life of the plant. The former should be used in a reproduction estimate and the latter only as an addition to the cost of construction as found by the Past Cost method. Here again it should be remembered, that the results by either one of these theories give us, not the value of the income, but one measure of that value.

When all of the items mentioned above have been estimated and included, the Reproduction Value is complete, and there remains only a broad review of the problem, and the fixing of the final or Service Value of the property. If the data are available, the value of the plant should be estimated by all of the methods outlined above, and the final value fixed by a comprehensive study of the several values obtained.

EDITORIALS

One early result of the Ohio flood is that interest is being displayed in river regulation problems by state legislators and by many persons who probably never thought of the subject before. There is an active, if unorganized, campaign to find a specific means of preventing river floods. One outgrowth of this is a river-regulation bill, introduced into the Ohio Assembly on Mar. 26. The Cincinnati *Enquirer* reports:

> In the belief that the flood damage can be lessened and the washing away of arable soil prevented in great measure by straightening the courses of rivers and creeks, Representative James Carroll, of Franklin, offered in the General Assembly a joint resolution for the appointment by the Governor of a commission of three members to investigate in conjunction with the Superintendent of Public Works the practicability of straightening channels of streams for increasing their capacity to carry off storm water without overflow. Provision is made for lease by the state of increased water power resulting from swifter flow of the current in straighter channels. The resolution was drafted by Representative Adam Frick, of Scioto, who believes that to straighten the channels of rivers and creeks would do more to prevent damage from floods than anything else, except reforestation, and that the receipts from water and electric power which the state could develop would more than pay the cost.

Out of the darkness will come light possibly. A few engineers have long realized that here, as in Europe, the work of scientific river regulation must sooner or later be undertaken. It requires such vast destruction of property and life as that which the past week has witnessed to make the public understand that the obstruction of river channels must not be allowed to continue without some safeguard for the public interests. But unless the work is placed in the hands of competent engineers, the legislators may only succeed in making a bad matter worse.

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The death of Mr. J. Pierpont Morgan removes from public life the most remarkable financier and business man of his generation; in fact, the most notable probably that has ever appeared in American financial history. The most essential feature to success in a large measure in the banking and financial world is confidence, and there is no doubt that Mr. Morgan had the confidence of business men and men of wealth both in this country and abroad to a greater degree than any other American financier. Some of the great fortunes which have been amassed in Wall St. were won by methods of destructive financiering which caused the names of those who won them to become a synonym for corruption and dishonesty. The vast profits reaped by Mr. Morgan and his firm, all impartial critics will agree, were gained by constructive methods.

It is perhaps a risky matter in the present conflicting state of public sentiment to express an opinion as to the public service rendered by Mr. Morgan in his business career. We believe, however, that those able to look at the matter without prejudice will agree that Mr. Morgan's services to the business and financial world have been of inestimable value, and that his influence for sound and safe business methods and for honorable and honest standards of business conduct throughout the wide range of industries in which his firm had a voice has been of vast benefit to the public as a whole, even though it has been little realized. Mr. Morgan has also been a lavish giver for many public causes. The passing away of such a commanding figure is indeed a national loss.

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An unusually well considered and comprehensive bill for state control of the conservation, development, distribution and use of the natural water resources of Pennsylvania is now before the Pennsylvania legislature. The bill is so fully outlined elsewhere in this issue that we will not attempt to summarize it here. Many of our readers will be particularly interested in its provisions for full state control of dams, including their location, design, construction and maintenance. Of all the states of the Union, Pennsylvania has had the most severe lessons as to the need of state supervision by competent engineers of the construction and maintenance of dams. The Johnstown disaster and the Austin disaster destroyed property enough to have paid the cost of supervision of dam and reservoir construction in the state for a century, to say nothing of the enormous loss of life in those great calamities. It goes without saying that many other states ought to take similar measures for the protection of the public and for a broad control of the water resources of the state so that they may be utilized to produce the greatest measure of public benefit.

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State Water-Power Development in New York

A very active controversy is in progress in the New York Legislature at Albany over the project to have the State itself develop water power from some of the surplus waters of the Barge Canal, generate electricity and sell current to consumers in the near-by cities. If the State were to undertake such water-power development, it would come into competition with the private companies now engaged in the sale of electric current. Naturally these companies are making a strong fight against the proposition.

Many of the arguments brought forward by them are weighty and deserving of attention. In their zeal to prove their case, however, they have unfortunately been extremely careless in the use of figures. In a letter distributed to the press on Mar. 28, the following appears:

> In publications of the State Conservation Commission, it is asserted that a million and a half horsepower of water power is running to waste and the Conservation Commission purposes to develop this for the State. As the United States Census places the cost of electrical development at $525 per kilowatt, exclusive of cost of a distributing system, it is easy to figure that a horsepower being equal to 746 watts, the cost for such a state-wide development assumes very large proportions. It is variously estimated at from three to six hundred million dollars.

We do not know when or where the United States Census has placed the cost of electrical development at $525 per kilowatt; but even if it has been guilty of such an absurd and extravagant statement, the officials of the electric lighting companies who are fighting this conservation proposal should know better than to offer such

figures to the public. Such a careless use of figures is, in fact, a two-edged sword. If it were indeed true that the present cost of electric power development was any such enormous amount as is here affirmed, then the estimates of the cost of developing the Barge Canal water power would by comparison be so small that there would be no question as to the wisdom of the State undertaking the work.

It is very likely true that the value of and the possibilities from the use of the surplus Barge Canal water for hydro-electric power development have been largely overestimated. On the other hand, it is well known that in the past the water stored by the State for canal purposes has been largely used for power development under leases which have been exceedingly profitable to the private parties holding them, and have brought in only trifling revenue to the State. There is, therefore, some reason back of the public demand that the large surplus power which the Barge Canal storage will make available should be developed by the State for the public benefit and not leased to private parties under conditions which will not bear investigation.

Examinations and Licenses for Engineers

We recorded in our last week's issue the reappearance of a bill in the New York Legislature to place the engineering profession under the control of the State Board of Regents and require engineers to pass an examination and have a state license as a precedent to the practice of their profession.

We have in previous years so fully discussed in these columns the general proposition embodied in this bill that we need take little space for its discussion at the present time. As our older readers at least can testify, ENGINEERING NEWS has for many years taken an advanced position in favoring state control and regulation of many matters affecting public welfare. The past quarter century has seen enormous progress in the extension of state and federal regulation of industry and commerce. We are well aware, however, of the serious limitations to the efficiency of government work, and we believe the general rule which ought to be followed is that the State should not interfere with any private enterprise or occupation except when it is clearly established that such interference is a necessity for the public welfare. We have yet to see any proof that interference by the State with the practice of engineering is necessary for protection of the public or that it would in fact, effect any measure of public benefit. We recognize that many excellent members of the engineering profession have come to believe that state regulation of engineering practice will in some way better the conditions of engineering employment and engineering compensation; but we are unable to see any sound foundation for such a belief. ENGINEERING NEWS has been foremost in opening its columns to the discussion of the status of engineers, and to suggestions of methods by which the conditions of engineering employment can be improved. We welcome such a discussion for we are firmly convinced that united action by the profession is essential if the status of the profession is to be bettered. But the records of experience both here and abroad furnish conclusive evidence that the proposal to place the whole engineering profession under state control means no benefit to the profession, but a serious injury.

There are, we are aware, a number of eminent engineers who have come to believe that some sort of state regulation of engineering practice is inevitable; and that since it must come sooner or later, it is not worth while to take the trouble to oppose such legislation. We cannot subscribe to such a view. There is no public demand whatever for the passage of laws to restrict the practice of engineering. The bills which have been introduced and pushed in the New York Legislature appear to be solely due to an organization of which nothing but the name is definitely known, its list of members and its officers being kept a secret. It is well known that the difficulty of securing the passage of even most excellent and desirable legislation, unless it has some political backing, is very great. Past experience has shown that it only needs a clear presentation before a legislative committee, by responsible engineers, or representatives of rsponsible engineering societies, of the facts regarding the engineers' license scheme, to cause any such bill to be killed without question.

Eternal vigilance was long ago said to be the price of liberty. The engineering profession should be willing to make some effort each year, if necessary, to protect itself from unwise legislation tending to restrict its liberty of action.

To those who hold the position that licenses for engineers are inevitable or that such licenses ought to be required, we suggest that instead of attempting the well nigh absurd task of branding with the title "licensed engineer" every man who has graduated from an engineering school, they attack the problem in a more intelligent way, and require licenses not for engineers in general but for special branches of engineering work. There are, for example, sound arguments in favor of the proposition that those who engage in the work of land surveying should be examined and licensed. Such a thing is entirely practicable and has in fact been carried out in many cities. If those who are anxious for engineers' license legislation wish to undertake something of real public benefit, let them secure expert aid, draft a model license law for land surveyors and secure its enactment in the different states of the Union. .

If they wish to proceed further in the promotion of legislation to benefit the public and the engineering profession, let them secure in each state the enactment of a law creating a state department of public works under direction of a state engineer, which should not only have control and direction of the engineering works carried out by the state direct, but should see that the public welfare is safeguarded in the construction and maintenance of dams, reservoirs, highway bridges, and numerous other works where carelessness or incompetence on the part of the engineer may cause injury to the public welfare.

It is often said that engineers ought to be examined and licensed because lawyers and doctors are; but there is a better way to protect the public against incompetent engineers than can be done by any examining and licensing system. It is possible to inspect the plans and the work of the engineer and protect the public in that way. No such system is possible in connection with the work of the lawyer or the physician.

The Flood Disasters in Ohio and Indiana

At the time our last issue went to press, the first news had just arrived of the disastrous flood which visited many cities in Ohio and Indiana on Mar. 25. The extent of the damage to property and to life, however, was not at all realized from these early dispatches. The great extent of area which the floods covered, the interruption of the railroad and mail service, as well as of telephone and telegraph communications all have contributed to make the full extent of the disaster even now a matter of uncertainty. In fact, as has happened in other great disasters, such as the Johnstown flood, the Galveston hurricane, and the St. Louis tornado, the exact loss of life can never be accurately determined. As to the damage done by the floods to the property of railways, states, cities, manufacturers, merchants and private individuals, there again only the vaguest approximation can ever be made.

From the reports now available from the flooded districts, however, it appears probable that the damage done as a result of the rain storm of Mar. 23 to 27 in Indiana, Ohio, western Pennsylvania, and New York will exceed that ever caused by any storm on record in this country.

Accurate records of the storm's extent and severity are still lacking. The difficulty of communication with the flooded districts, and the terrible destruction to life and property which has turned the attention of all responsible persons to the immediate work of relief makes it doubtful whether accurate records of the rainfall and of the volume of the flood flow in the various rivers will ever be gathered.

Such records are of interest and importance to the civil engineer and we hope that any of our readers in the flooded districts who may have been able to make even approximate records of rainfall or stream flow will communicate their observations either to us or to Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey, which organization will without doubt collect data concerning the floods.

The rainfall which caused these destructive floods was part of a general cyclonic storm which began on Easter Sunday, Mar. 23, and swept a broad belt of country from Wyoming eastward through Nebraska, Iowa, Illinois, Indiana, Ohio, Pennsylvania and New York, terminating on Thursday, Mar. 27. The destructive tornadoes which caused great loss of life in the cities of Omaha, Terre Haute and many smaller places on Mar. 23 were a part of this general storm.

As to the extent of territory subjected to heavy rainfall, this is really more accurately determined by the reports of floods in the various streams than by the Weather Bureau reports of rainfall because the Weather Bureau stations from which telegraphic reports are received are located long distances apart. Further, the flood damage interrupted telegraphic communication from some of the stations where the storm was most severe.

Weather Bureau rainfall records are as follows:

Station	Period covered March:	Total rainfall inches
Terre Haute, Ind	24 and 25	3.64
Indianapolis	24 to 26	5.38
Louisville, Ky	25 to 27	5.94
Toledo, O	24 to 26	5.46
Cleveland, O	24 to 27	7.08
Columbus, O	24 to 26	5.94
Pittsburgh, Penn	24 to 27	3.46
Erie, Penn	24 to 27	6.14

These records supplemented by others more fragmentary, with the reports of flood heights indicated that the heaviest rainfall occurred on Mar. 24 and 25 in Northern Ohio and Indiana and was probably most severe along the belt of fifty or a hundred miles of highest land where the rivers have their source which flow southward to the Ohio and northward toward Lake Erie.*

The rainfall records at Indianapolis, Toledo, Cleveland and Columbus indicate the probability that this section of heaviest rainfall probably received a precipitation of 5 to 7 inches or even more.

This rainfall came at a time when the ground was well saturated by previous rains and at a time of year when evaporation is almost *nil*. A very large percentage of this rainfall, therefore, flowed at once into the streams; and while the average slope of the area covered is quite moderate, the rivers draining it also have a moderate slope, so that the accumulation of water in the valleys was enormous and far beyond all previous records. The Ohio River tributaries which have been at high flood stage and have caused the greatest damage, naming them from the west toward the east, are the Wabash, the White River and the Whitewater River in Indiana, the Miami, the Scioto and the Muskingum in Ohio, and the Beaver and Allegheny in Eastern Ohio and Western Pennsylvania. The intensity of the storm in the northern part of Indiana and Ohio is further indicated by the high-flood stages in the Maumee, the Sandusky and the Cuyahoga, flowing into Lake Erie.

Judging by the reports of life and property loss, it seems probable that the heaviest rainfall and highest flood stages were recorded on the Miami River and its tributaries. The city of Dayton, where the greatest destruction occurred, lies in the valley of this stream. The life and property destruction, however, is, of course, dependent even more on the local topographical conditions in a city than upon the flood height of the stream flowing through it.

To what extent the failure of dams or reservoirs may have contributed to the life and property loss is impossible at the present time to state. The press dispatches which have reported the breaking of this, or that or the other dam or reservoir or dike are by no means to be accepted at their face value and most of them have been contradicted by later information. In the panic, fright and confusion attendant upon such a flood, all sorts of vague wild rumors are set afloat and given quick credence.

Most of the reservoirs referred to in the dispatches as failing or threatening to fail, are probably those which were built nearly a century ago in connection with the old Ohio state canal system. With the practical abandonment of the canals for many years past, the maintenance of these reservoirs has been more or less neglected. It would not be at all strange that, subjected to such a heavy rainfall, some of these reservoirs should have given way. We believe, however, that most of these reservoirs, although of considerable area, are of compar-

*Since the above was in type this conjecture has been confirmed by later reports from the Weather Bureau recording a rainfall at Marion, Ohio, Mar. 24 to 27, of 10.60 in. Marion is located in the central part of the state, some 50 miles north of Columbus, and is within a few miles of the summit dividing the Lake Erie and Ohio River drainage basins. At Bellefontaine, 40 miles southwest of Marion, near the headwaters of Spring Creek, which joins the Miami River at Dayton, the rainfall in the same period was 11.16 in. At Bangerville, 30 miles east of Marion, 9.50 in. was recorded. At Wooster, 70 miles east of Marion, on the headwaters of the Muskingum River, 9 in. of rain fell, Mar. 24 to 26.

atively shallow depth. If the total volume of water they held had been discharged, it could not have made a very great difference in the flood height of the rivers below. If, however, their breakage should cause a sudden rise of the streams which would catch people before they had time to escape from the flood's path, their breakage may have had something to do with the loss of life.

At more than one place it is reported that the breakage of levees along the river front was responsible for a sudden rush of the river's flood through the streets and consequent loss of life. If this report is confirmed, it will be of great interest to engineers, since it points to the desirability of building river-front levees of ample height and strength if a city is to have such protection at all.

What is equally obvious, however, is that if a city is to be rendered reasonably safe against floods, ample width must be allowed for the passage of a flood flow through it between protecting embankments. The obstruction of the channel by bridge piers, etc., or by fixed dams must be kept within reasonable limits. It is noteworthy that among the bridges reported destroyed by the floods are some very substantial concrete arch structures erected within recent years. One at least of these, the famous Y Bridge at Zanesville, Ohio, is said to have been dynamited, doubtless to reduce the obstruction to the river's flow.

Such extraordinary floods as this emphasize the wisdom of crossing such rivers with long spans and few piers rather than the opposite course. It is common in estimating on the economic length of spans for a bridge structure to consider only the relative cost of piers and superstructure. Such extraordinary flood flows emphasize the wisdom of choosing long spans and fewer piers, even at somewhat greater original cost of construction.

It should be emphasized, however, that the engineer should not be held responsible for the inadequacy of bridges to pass such extraordinary floods as the present. The waterway at a bridge should be sufficient to pass all ordinary floods with safety; but to make it sufficient to pass the extraordinary floods which may come once in a century or in two or three centuries would make the cost unreasonably great and in the Miami and Cuyahoga Rivers at least, present indications are that the flood flow has far surpassed all previous records. This may very likely be true also of the other rivers mentioned above.

A question of great interest is what flood stages may be expected in the lower Ohio and lower Mississippi valleys during the next few weeks. Everything depends upon the extent to which the flood waves from the different tributaries may chance to synchronize with each other, and also upon the extent to which the flow in these and other Mississippi River tributaries may be augmented by additional rainfall within the next two or three weeks. The flood in the Allegheny and in the Ohio and Indiana Rivers named above will be sufficient to keep the Ohio itself above the danger stage at various points for probably at least a fortnight to come.

Fortunately, so far as present information extends, the rainfall has not been heavy on the drainage area of the rivers flowing into the Ohio from the south and west. That there will be high water and an anxious time along the lower Mississippi for a month to come at least may be taken as certain. It is of much interest to note that a very heavy rainfall on a comparatively small portion of the drainage of the Ohio alone can cause high water in the Mississippi, with its other tributaries merely at a normally full stage.

The widespread destruction of life and property wrought by these floods will doubtless give renewed life to the agitation for reservoir construction as a means of river regulation, and even for reforestation as a means of lessening the destructive effect of floods. The argument for such preventive measures may seem convincing to a layman; but to an engineer it seems to us the lesson of the disasters in Ohio and Indiana is rather the futility of any attempt which man can make toward storing the rainfall either by planting forest trees upon the watersheds or by building dams and reservoirs upon the smaller tributaries. Every hydraulic engineer who knows anything about rainfall and runoff knows that a rain precipitation of four to seven inches depth coming on top of ground already saturated will produce high flood stages in the rivers draining such a region no matter if the entire drainage area were covered with forest.

When we turn to the proposition for artificial storage it must be seen that what is perfectly feasible on such little rivers as those which furnish water power to small mills in Rhode Island, or furnish water supply to New York City and Boston, becomes a task of impossible magnitude when dealing with a river draining thousands of square miles.

According to the press dispatches, the Miami River, which wrought such destruction in Dayton and Hamilton and Middletown, was at its highest stage a stream three to four miles in width covering to a great depth the entire bottomland between the bluffs. To thoroughly safeguard against such a flood, would mean building reservoirs of enormous capacity, and having them empty or practically so, when the storm arrives which is to test their usefulness. Moreover, to achieve the desired security, such reservoirs must be built not only on one stream, but on every stream. A vast amount of damage was wrought during the last week by comparatively small tributaries which were swollen for a short time to great rivers.

In saying this we should not be understood as condemning wholly the reservoir system of river regulation, for, as has been pointed out in these columns, lessening the destructive effect of floods is only one function and perhaps one of the least valuable functions of reservoir storage on a stream's headwaters. There are probably cases where under favorable topographical and other conditions the construction of storage reservoirs may be a wise measure, especially for the maintenance of the low-water flow in times of drought in connection with the use of the water for the production of power.

A feature which is not without interest to the engineer is the severe test which the recent floods have given to the foundations of buildings, bridges, dams, etc. Perhaps there are few cases where an engineer lays the foundation of an important building that he plans to have it withstand safely the effect of high floods. Where a building is located on a river bottom which may be submerged to considerable depth by high floods, it is certainly well to take this into account and to see that foundations are so built that they will not be undermined and that the building walls have sufficient stability to withstand the force of any current that may come against them.

LETTERS TO THE EDITOR

The Study of Foreign Languages in Technical Schools

Sir—After reading Prof. W. H. Herschel's paper and your editorial on Modern Languages in Technical Schools, published in your issue of Feb. 27, I beg to call your attention to the common practice abroad, which is the obligation of studying one language, not two, leaving the choice to the preference of the student. The advantages of this solution are:

1. It gives the student the possibility of using in a better way his personal ability and previous opportunities. One may learn more easily one language than another, and also one may have had opportunity to learn fairly well a certain language in his youth.

2. It gives the country at large all the benefits which can be possibly derived from the knowledge of the different languages by engineers.

It seems to me it would be a great mistake to limit the study of foreign languages to one all over the country, whatever it may be. It is preferable to limit it to one language for each individual, leaving the choice between two or three to the option of each.

C. SIQUOT.

6 East German St., Baltimore, Md.
Mar. 3, 1913.

The Study of Foreign Languages by Engineers

Sir—Your issue of Feb. 27 contains an article by Prof. Winslow H. Herschel on "The Study of Modern Languages in Technical Schools" and an editorial, "Why American Engineers Should Know the German Language." As the question of the study of modern languages, to assist engineers in their professional work, as well as to give them a liberal education, is a very timely one, a few remarks regarding my own experience and the conclusions gained from it, may furnish some additional thoughts.

When a boy I learned both the German and French languages by being sent to Europe for my education. The advantages which I have obtained therefrom both in my profession and in general, have been so satisfactory to me that I have followed the same plan with all of my five children. They have all been in a German and in a French speaking country for at least one year, and thus learned these foreign languages readily in their youth.

The advantages of knowing German and French are not merely ornamental, or, as Dr. Waddell says concerning French, "only a gentlemanly accomplishment." They are also of great practical value, as you intimate in your editorial and as stated by Prof. Herschel. A mechanical or chemical engineer especially, and a civil engineer only slightly less, miss much encouraging inspiration at the centers of progress in these professions, through lack of familiarity with at least the German language.

It is not merely the ability to read foreign engineering literature that is of advantage to the engineer. It is the personal contact and personal conversations with the engineers and investigators that are of most benefit to us. Many things are said that are not written, and many ideas are talked about that are a spur to further progress, long before they are sufficiently crystallized to be embodied in published articles or books.

It is easier and requires much less time to learn foreign languages in childhood and when we constantly hear them spoken around us, than in the tedious, slow and irrational way in which they are generally taught in our schools.

If it is not practicable, because too expensive, to send our children abroad for one or two years, it may become practicable, within a decade or two, to have established in our own country similar and less expensive opportunities for children to learn foreign languages in a natural way. This would be possible at large German or French boarding schools located in secluded and healthful places where the entire environment and management can be suitably arranged for the purpose of teaching, for practical use, either foreign tongue, within one or at most two years.

In French Switzerland, there are boarding schools where a large number of the scholars are English and American. The instruction in all general branches is in the French language, so that, besides advancing in the general studies, the foreign scholar acquires the use of a new and live tongue. An American scholar in a similar school in our own country could study mathematics, history, drawing, Latin and other branches for a year or two as well in French or German as in English and not be the worse for it in after life.

Certain restrictions would be obligatory. No communication could be allowed with the outside world except for a short time and at intervals of a month or two, or by letter. Following further the practice of the above-mentioned Swiss schools, from a designated time after entrance no conversation among scholars would be allowed except in the language to be acquired. All teachers, attendants and servants would naturally be required to speak only the language of the school. All games, sports and other recreations would be conducted in the same language.

This idea of special language schools where the scholars should remain but one or two years, was originally suggested in Europe; but owing to the fact that European countries are comparatively small, it is easier to send a child at once to a neighboring foreign country and this is now the usual custom. In our country of large dimensions and rapidly developing educational interests, it does not seem impracticable to have a few such one- or two-year course German, French and Spanish schools, successfully conducted in suitable localities, where the

cost of attendance could be brought within the means of the average family.

RUDOLPH HERING.

170 Broadway, New York City.
Mar. 7, 1913.

The German Language as an Indispensable Element of Engineering Progress

Sir—The great value to American industrial progress of a knowledge of the German language on the part of our engineers, as pointed out in Prof. Winslow H. Herschel's article in ENGINEERING NEWS of Feb. 27 and in your editorial, is too little realized by our manufacturers and the profession in general.

There is some encouragement to be found, however, in the improving point of view which is in marked contrast to opinions encountered a few years ago, when it was actually argued that German for engineers was a waste of time. In a letter of mine, published Aug. 12, 1909, in answer to a statement of Mr. J. G. White before the A. I. E. E. (discussing Dr. C. P. Steinmetz' paper, "The Value of Classics in Engineering Education") that "scarcely one graduate in 10,000 had any real use for German," I pointed out some of the reasons why German is only second in importance to English itself, all of which still holds good in an even greater degree as events are constantly demonstrating.

There is, in fact, no single collateral subject of as great importance to engineers as a knowledge of German, although this is likely to be contradicted by those most ignorant of the facts in the case. The value to our industries of a knowledge of German on the part of our engineers would be almost incalculable. Their ignorance results in a correspondingly great loss and it is not too much to say that we are five years behind the times from this one cause alone. Yet not only is the engineering profession blind to the benefits of German, but it refuses, for some reason, to become enlightened. It is a case of none being so blind as those who will not see.

An exactly opposite course is followed in Germany, although she is far ahead of English-speaking countries in engineering. There is more English read in Germany than there is German read in English-speaking countries all over the world. The result is that the Germans instantly adopt every possible British or American improvement while we are years behind the times in adopting German improvements. This is one of the secrets of Germany's great progress, and is a practice which will continue to keep her in the lead.

It is, however, of very much less importance for Germany to do this than it is for us to keep up with German improvements for out of the English chaff she can find but few ideas of value compared to the rich supply that awaits us in her improvements. The German system of education is a generation ahead of ours and she is turning out a body of engineers, scientists and technical men who have little or nothing to learn from us while our systems of education and manufacture have the effect of choking off as far as possible all individual initiative and progress and of crowding into the rut of standardization every original idea that may manifest itself.

Some of our largest manufacturers, instead of developing the initiative of their workmen, keep them as far as possible in the class of automatons and obtain as large a proportion as possible of the annual output of graduates of technical colleges for shop positions. In the guise of benefiting these young men, who are paid an insignificant wage, a lot of work is gotten out of them and they are turned out in due course of time as practically experienced men. They have, however, been so thoroughly imbued with the methods and practice of the manufacturers that they know little or nothing of anything else, and are entirely ignorant of foreign improvements. They carry their biased knowledge away with them and the whole stream of engineering is contaminated with this drain of standardization. In specifications, even, written by such byproducts of manufacturing monopoly, apparatus is specified not by name, which would be unfamiliar to the graduates, but by the catalogue number of the manufacturers, as if no other manufacturers ever made such apparatus. Yet this whole influence is exerted in the name of the good of the profession!

There is small wonder that from such sources there should come no encouragement to learn German, as long as antiquated standardized products can be forced on the public to avoid and discredit foreign improvements.

As a result of her wonderful educational system, her progressive attitude on all public questions and her modern methods in industry, finance and business, Germany is far ahead of other countries. The true state of affairs being concealed to a great extent from American understanding by ignorance of the German language, and still further beclouded by special interests, we are unable to take advantage of German discoveries and must therefore straggle far behind. Yet those German engineers who come to America for the purpose of disseminating new ideas meet with jealousy and lack of coöperation. They find that our manufacturers and engineers not only do not know what is going on abroad, but are content to remain in ignorance and even when the truth is demonstrated are loath to admit it, which is, though not commendable, at least understandable, since they do not like to concede that progress has been made which they themselves should have made had they been properly diligent.

The profound ignorance of German affairs is, to put it mildly, surprising. A few examples taken at random will serve to illustrate it. The American Society of Civil Engineers displays in its library, charts showing the growth of our national engineering societies as compared with the leading British and French engineering societies. These charts are very instructive as far as they go, but the most prominent engineering society in existence is conspicuous by its absence, namely, The Verein Deutscher Ingenieure, the leading society of Germany which numbers among its members the most eminent engineers throughout the world, besides being the largest of all engineering societies, as is well known. Its membership has in the past decade perfected more inventions and improvements and made more researches, than are credited to the members of all other societies combined, and it has undoubtedly proven the greatest single factor in the progress of the world during the present century.

If our technical press and even the general press de-

voted space to describing the triumphs of the engineers of this society instead of wasting paper and ink on the trivialities with which their columns are crowded, vastly different conditions would prevail in this country today.

An concrete example of the kind of welcome that meets a German improvement in this country is seen in the case of a certain CO_2 recorder which came into notice several years ago. In a paper on the subject of Power Plant Economy, read before the A. I. E. E., it was stated that this recorder accomplished remarkable results, but the inference was given that it was a British improvement. This was due either to ignorance or malice, between which there is not much to choose. The apparatus, as a matter of fact, had been for many years in successful use in Germany where it originated.

In a paper on Steam Pipe Covering, read before the Association of Edison Illuminating companies, the results of extensive and costly tests of steam pipe covering were reported and it appeared that a certain German covering showed an efficiency of 86.9% while the best American covering showed an efficiency of 84.2%, a difference of 2.7%. This covering, however, was discredited, as being inflammable. The tests had been made on ordinary high-pressure steam pipes. As a matter of fact, this particular pipe covering had long been and is still being widely used in Germany on superheated steam piping, proving non-inflammable at temperatures far beyond those which can ever be employed on our own prime movers, for American manufacturers are entirely unable to build prime movers for high degree superheated steam, failing accordingly to obtain the low steam consumption of 9 lb. and less per horsepower hour, so common in German practice. At the conclusion of the paper the facetious allusion of "made in Germany" contributed no little to the entertainment of the gathering and it was reported in the same spirit by the engineering press.

An occasional engineer recognizes the value of German progress and attempts to take advantage of it by using German formulas without understanding the German language. The result, is of course, far from a happy one. Young engineering students are more appreciative and often attempt translations of highly technical material but without being competent to do it, while such experienced engineers as are competent have but little time for translations, and for this reason a great amount of valuable material will always remain unavailable until our engineers, as a rule rather than an exception, understand German. Translation for itself seldom offers sufficient remuneration to be properly done, and is always more or less a labor of love, which passes with but little credit or appreciation.

The failure of our engineers to keep uptodate is the cause of enormous losses to manufacturing and industrial undertakings all over the country. Numerous failures and gross inefficiency in engineering undertakings produce stagnation, for our bankers, by bitter experience have learned to distrust our slap-it-together engineering methods and refuse to invest in new projects, particularly in hydro-electric and other power developments, which in turn prevents other dependent industries from coming into existence.

Quite the opposite condition obtains in Germany where bankers not only invest German capital in German undertakings but make calls on foreign capital, especially from France, since on account of the efficiency of German engineers, they can show profits on engineering undertakings which cannot be realized by the bankers and engineers of any other country.

This is all accomplished without the hurrah which accompanies such movements as "scientific management," as we know them. The thing that is called by this fine name in America is only regarded as common practice in Germany where the writer, for example, employed it in his shop practice some 18 years ago, being instructed by his superintendent who had practiced it for some 40 years, quite innocent of its future fame in America. The writer in 1904 had occasion to make a report on a power plant in the United States which resulted in a saving of more than $200,000 a year in operating expenses, while in a smaller plant $50,000 a year was saved, without dreaming that the processes recommended were later on to be classified as "scientific management."

If our engineers were really efficient and uptodate, we could not only save millions of dollars per day in our engineering, industrial and administrative undertakings, but could obtain an enormous foreign trade and could give our capitalists opportunities for great new investments which cannot now be made on a profitable basis. Simply the knowledge of German on the part of a few thousand engineers would accomplish this since they would not then have any excuse for ignorance or lack of progressiveness. The country is paying a large price for our engineering inefficiency.

The same condition is found in England as is recognized by those who are familiar with conditions. In a speech made in the British Parliament the truth was pointed out in these words:

> One of our greatest failures is that less than 1 per cent. of our engineers and officers understand the German language: everything that we wish to know of German progress must come to us second-hand in insufficient and delayed translation; today we are at a point where Germany is able to build ten ships against our one; we have to learn to imitate Germany.

How indispensable a knowledge of the German language is to our engineers is obvious. It is to be hoped that the engineering profession will be spared any further exhibitions on the part of those who take pride in their ignorance.

FRANK KOESTER,
Consulting Engineer.
50 Church St., New York City.
Mar. 7, 1913.

Multiple Headings in Rock Tunneling

Sir—The writer's attention has been directed to the interesting article published in your Feb. 13th issue, by John F. O'Rourke, entitled "Elimination of Timbering in Rock Tunneling: A Proposal." Although not wishing to venture upon criticism of the merits of concrete-block lining for rock tunnels, as outlined by Mr. O'Rourke, the writer cannot abstain from commenting on the method proposed for driving rock tunnels.

It is a fact only too well known that, comparatively, heading excavation is the costliest item in tunnel excavation; and on the success of driving the heading depends to a large extent the successful completion of the tunnel.

In modern tunnel practice the tendency is to keep the number and size of headings down to a practical minimum. In this country one heading only has so far been advocated as being most advantageous to drive railroad tunnels. In Europe, only rock tunnels over two miles long have been and are driven with a top and one bottom heading, the reason being obvious, for the greater the number of headings, the more complicated the driving operations are, and it is only with a first-class organization of men and mining operations, and on long tunnels, that a tunnel can be driven successfully with two headings. The tunnel must be long enough to warrant such an organization to be made available, and the necessity for rapid driving must be warranted by the capital invested, time being of the essence for an economical completion of the work.

The driving method proposed by Mr. O'Rourke would involve three headings, the area of which would represent one-third of the total tunnel section, as against two headings aggregating one-fifth only of the tunnel section. All contingencies pertaining to the driving of a bottom heading would be practically duplicated, not speaking of the drilling equipment, tracks, rolling material, air and ventilating pipes, working shifts, etc.

The operating conditions would also be greatly complicated, and only one familiar with the top-and-bottom-heading method can appreciate these features.

Why not first try methods which have been used abroad, modifying them so as to suit local conditions? Within the past ten years the top-and-bottom-heading method has been used successfully in driving the following tunnels: Simplon, 65,042 ft. long; Loetschberg, 47,680 ft. long; Weissenstein, 12,136 ft. long; Ricken, 28,200 ft. long; Wasserfluh, 11,666 ft. long. This very same method is used at the present time to drive the tunnels of: Hauenstein (26,683 ft.), Mont d'Or (20,021 ft.), and Granges (28,093 ft.). This tunneling method would not interfere with the use of interlocking concrete blocks as illustrated in Mr. O'Rourke's article, and it is the writer's belief that in tunnels subjected to moderate ground pressure the use of such blocks will be found advantageous, without, however, doing entirely away with the timbering. It should be borne in mind that timber segmental arching for tunnel work is costly and inadequate where high and unbalanced pressure prevails, and usually a timbering method similar to that used in Alpine tunnels has to be resorted to.

This naturally makes impossible the use of traveling steel or timber forms supporting the lining, and the masonry has to be laid in short sections or rings, by taking down the temporary timbering as the lining progresses. In such cases a tunnel lining formed of interlocking blocks might prove advantageous by reason of the speed with which the lining could be placed in position.

E. LAUCHLI.

2 Wall St., New York City.
Mar. 12, 1913.

[The above discussion was submitted to Mr. O'Rourke, whose reply follows.—Ed.]

Sir—Mr. Lauchli takes the ground that by the use of the three headings shown the expense is largely increased, and calls attention to the general practice of keeping down the number and area of the headings to a minimum.

I may not have gone into sufficient detail to be perfectly clear, as to the conditions under which the use of concrete interlocking blocks is suggested as a substitute for timbering. I had in mind, however, the timbering of tunnels through rock more or less broken and what is called heavy, and not for tunnels where the superimposed mass is so great that movement occurs, which under less weight would be perfectly safe without timbering. With this in mind, it is no longer a question of the cheapest system of excavation, but the most practical one, which permits of doing the work without excessive "falls." To accomplish this purpose, two side headings are necessary for placing the bench walls, and a top heading would most likely be found desirable to facilitate and minimize the amount of excavation required immediately in front of where the lining is being placed. Moreover, the driving of headings in the character of rock assumed is not so costly as in stronger rock, which seems to be that considered by Mr. Lauchli. As the side headings are inevitable, I see no reason for modifying my views expressed in the former article.

I would like also to add that I fully agree with Mr. Lauchli in all he says as applied to the character of rock encountered in the tunnels he cites, and am also greatly pleased to find that he considers the interlocking concrete blocks superior to concrete laid upon forms in place under the timber conditions in his tunnels.

The main idea of my former article was that by the use of interlocking blocks, timbering might be eliminated with a gain both in speed and economy and Mr. Lauchli's communication seems to confirm that belief.

JOHN F. O'ROURKE.

315 Fifth Ave., New York City.
Mar. 20, 1913.

Flow of Liquids through Narrow Rectangular Channels

Sir—In ENGINEERING NEWS, of Dec. 19, 1912, was an article by Ernest Jonson giving a series of tests of the leakage around a piston closely fitting in its cylinder, with corresponding calculated leakages based on analysis.

The figures show a remarkably close corroboration of the measured flow with that given as calculated, but the details of tests and of computation indicate that such corroboration is not to be expected on theoretical grounds, and may be the result of the accidental balancing of errors of weight.

(1) The increase of channel width owing to extension of the cylinder and compression of the piston is not negligible. Without having the structural details of the test apparatus it is not possible to determine these, but it is not unlikely that at the higher pressures used, 120 lb. in the first series, the increase of channel width may amount to 0.0001", indicating that the calculated flow figure should be increased 15%. This correction would decrease at the lower pressures.

(2) It is not stated that precautions were taken to maintain the piston concentric with the cylinder so as to give a channel of uniform width. If this was not done, it is possible that the piston was forced to one side of the cylinder, giving a channel width of 0 at one side, and a channel width of double the average at the opposite side of the piston. Under such conditions, and without any exact analysis, which would not here be warranted, it is

obvious that, taking the larger half of the crescent shaped opening, the mean hydraulic radius r at the point of maximum opening is twice the average, the rate of flow at this point is eight times the average, and the mean hydraulic radius r at the point of least opening is equal to the average, and the rate of flow likewise the average, and the average rate of flow for this larger half of the crescent is 4½ times the average caluclated on the assumption of uniform channel width. Ignoring the flow in the smaller half of the crescent, the total flow is still twice that calculated for uniform average channel width of $2r$. If the piston and clyinder do not touch at any element, somewhere between once and twice that given by the formula.

(3) In the first series of tests, the measured opening 0.0018 in. is corrected to 0.001946 in. to make the calculated flow agree with the measured flow over the greater part of the range. This correction amounts to 8% of the channel width and amounts to an increase of calculated flow of 26%. The data given does not seem to warrant this correction.

(4) The value given for the coefficient of viscosity

$$u = \frac{0.000013}{18 + T}$$

reduced to the usual C. G. S. units reads

$$u = \frac{0.018}{1 + 0.036\,t}$$

which corresponds to the figure obtained by the flow of water in glass tubes, and based on the assumption of no slip between the water and the glass. Where the walls are of bronze, such assumption is probably unwarranted, and the equivalent coefficient might have to be modified.

The test figures reported are of value, but the formula for flow should be used with an understanding of the limitations of accuracy not fully expressed in Mr. Jonson's paper.

It is of interest to note that the formula developed by Mr. Jonson is given in slightly different form in Lamb's Hydrodynamics, 3d Edition (Cambridge University Press, 1906), p. 542, and reads in Mr. Jonson's notation (correcting for typographical error)

$$\int_{-r}^{+r} v \cdot dx = -\frac{2}{3}\,\frac{r^3}{u} \cdot \frac{dp}{dl}$$

CHARLES B. BUERGER.

Department of Water Supply, Gas and Electricity,
21 Park Row, New York City, Feb. 18, 1913.

Sir—In response to questions raised by Mr. Buerger, I would say:

(1) The general character of the apparatus does not seem to justify any greater refinement than that used. An average enlargement of 0.00005 in. of the channel and a corresponding increase in the flow of 7% would be possible if there were no flanges on the cylinder and no solid top in the piston. The average enlargement of the cylinder might be roughly estimated as 1.5% at 120 lb. pressure with a corresponding increase of flow of 4.5%. This correction would somewhat decrease the average difference between the calculated and the measured flow.

(2) A piston clearance of 0.002 in. is equivalent to a sliding fit, hence the piston was self-centering.

(3) The correction is well within the limits of error in the micrometer measurements, and still more so within that of the apparatus. It is justified by the resulting close agreement between measured and calculated flow. In other words; the theoretical formula applied to the flow of a clean liquid gives a more accurate measurement of the hydraulically effective width of the channel than may be had in any other way.

(4) The assumption of slip in a liquid or between a liquid and a solid is utterly inconsistent with all hydraulic phenomena hitherto observed, and hence highly improbable. It is a well established law of hydraulics that the loss of head in a pipe is independent of the pressure. If the water slipped on the surface of the pipe there would be friction, which is a function of the pressure. There would thus be introduced an element of resistance which would be a function of the pressure. The close agreement between test results and calculations show that no slip occurred in the present case.

Mr. Buerger intimates that there are certain limitations to the accuracy of the formula given in my paper but he does not state what they are. There are no such limitations. The formula is absolutely accurate. Its applicability is, however, limited to the conditions for which it was developed. These conditions were defined in the original paper. They were: uniform (rectilinear) flow, relatively very small width of channel so that the resistance produced by top and bottom surfaces is not appreciable. If sides of the channel are so elastic that an appreciable enlargement will take place under pressure a formula taking account of this enlargement would have to be developed, but for such a formula there seems to be no practical need. Where there is any considerable enlargement it may be figured separately for each case and the resulting average enlargement added to the original width before introducing it into the formula.

ERNST JONSON.

Board of Water Supply, 147 Varick St., New York City.

March 5, 1913.

Proportioning of Foundations for Columns and Walls

Sir—I desire to make a correction in my article in your issue of Mar. 6, 1913, p. 465, on the "Proportioning of Foundations for Columns and Walls." On p. 465, second column, about 3½ in. from the bottom of the column appears the following sentence: "Columns 1, 2, 3, etc., carried 62½% of live load . . . . ," and five lines below " . . . . . carried 73% of live load." The word "live" should be "dead" in each of these cases.

While the method proposed is based on dead load, I have been asked why any part of the live load is considered. The reason is that in all buildings a part of the load, such as machinery, furniture, etc., is almost as steady as the permanent dead load and therefore should be taken into account. The allowance of 15% to 25% of live load should care for this permanent load usually.

My attention has been called to the fact that the method proposed, which readers will bear in mind was not claimed by me to be original, is given in the "Encyclopedia of Civil Engineering" published by the Amer-

ican School of Correspondence, which was not known to me when the article was written.

ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Ill.
Mar. 13, 1913.

Sir—In Mr. McCullough's article on "Proportioning of Foundations for Columns and Walls," the author does not explain the underlying principles involved so that it is impossible to determine exactly what he proposes. In the proportioning of footings as between dead and live loads a correct method involves an estimate of the actual live loads which will come on the footings at various times in the life of the building. This may vary in different classes of buildings from 5% to theoretically 100% of the floor loads used in calculating the strength of beams. It is impossible to proportion footings so that the unit load under all footings shall be the same if there is any variation in the live loads during the life of the building. The best that can be done is to select some condition of loading between the case of no live load on one hand and the maximum probable live load on the other hand, and proportion the footings so that for the conditions of loading selected the sum of the dead and live loads on the foundation bed will be uniform under all footings.

I have devised and used in my own practice, a method of proportioning footings involving the use of the maximum probable live load obtained by an estimate based on the probable use of the building, in place of the live load obtained by adding together the floor loads used in calculating the strength of the floor beams, or the use of any fixed proportion of such arbitrary floor loads. Furthermore, the method involves proportioning the footings, not for the maximum probable live load, but for one-half of the maximum.

By the use of this method the load on all footings will be equal when one-half of the estimated maximum live load acts on the footings. During erection, and before any live load acts on the footings, those footings having a high proportion of dead load will inevitably have the highest loading on the soil, and if the soil is compressible will at the time of the completion of the building have settled the most. As the use of the building brings the live load into action, the load on the supporting areas for interior columns will gradually increase. When one-half of the live load acts on the footings the unit load under all footings will be equal. It at any time more than one-half of the estimated maximum live load acts, then the unit load under interior footings will be greater than under exterior walls, but in general the variation in loading and the resulting difference in settlements will be the least possible under varying proportions of dead and live load.

DANIEL E. MORAN.

53 Liberty St., New York.
Mar. 20, 1913.

Sir—The writer was much interested in the article by Mr. McCullough on "Proportioning of Foundations for Columns and Walls."

The methods given can be stated somewhat differently and shown to be similar.

Let D = Dead load on representative column
" W = Total load on representative column
B = Bearing value of soil
D', W', and B' represent similar functions for any column in building

By the method given by Mr. McCullough

$$B' = \frac{BW'D}{D'W}$$

and the area of footing equals

$$\frac{W'}{B'} = \frac{D'W}{BD}$$

By the method given by Mr. Schneider

$$B' = \frac{BD}{W}$$

and the area of footing equals

$$\frac{D'}{B'} = \frac{D'W}{BD}$$

The methods then are alike and only give different results with the selection of different representative columns. In other words, the foundation is designed for the dead load arbitrarily increased for live load. The amount of increase being determined by some column selected as being representative, the measure of the increase is the ratio of the total load on the footing to the dead load.

Mr. McCullough selects the column with the least live load in proportion to the dead load, while Mr. Schneider selects the column with the greatest live load in proportion to the dead load. Between these two extremes there is a considerable range of choice.

The method of reducing live loads going to columns affects the size of the foundations. The writer believes that we should be conservative, in this respect, and favors the method used by C. C. Schneider in his "General Specifications for Structural Work for Buildings," mentioned by Mr. McCullough. It reads as follows:

> For columns carrying more than five floors, these live loads may be reduced as follows:
>
> For columns supporting the roof and top floor, no reduction. For columns supporting each succeeding floor, a reduction of 5% of the total live load may be made until 50% is reached, which reduced load shall be used for the columns supporting all remaining floors.
>
> This reduction is not to apply to live load on columns of warehouses, and similar buildings which are likely to be fully loaded on all floors at the same time.
>
> The live loads on foundations shall be assumed to be the same as for the footings of columns.

EDWARD HUTCHINS.

P. O. Box 255, Glens Falls, N. Y.
Mar. 13 1913.

The Railway Valuation Act

Sir—I have read with interest the editorial in your issue of Mar. 6 entitled, "A Huge Piece of Engineering Work," referring to the Railway Valuation Act, the full text of which appears in the same issue.

The caption of your editorial should alone serve a useful purpose. In the morning issue of the *Wall Street Journal* of Mar. 19, appears an article which quotes the Chairman of the Interstate Commerce Commission as follows:

> The work is one of great magnitude, but the Commission is not, as has been suggested, staggered or dazed by the duties that have been placed upon it. The work will be approached and proceeded with in a business-like, impartial and thorough way.

It is no reflection on the Commission or its Chairman if we suggest that the Commission is not "staggered"

by the duties to be assumed for the reason, possibly, that it does not yet comprehend the magnitude of this work and the insufficiency of the means provided by Congress for prosecuting this work "in a business-like, impartial and thorough way."

In this connection, you justly point to the unsatisfactory character of some of the work which the Commission is now prosecuting. Certainly the railroads should encourage the employment of the most competent engineers and accountants for this work. But this requires more than the encouragement of the corporations. It requires that Congress shall appreciate better the market value of the services of these men. The Congressmen naturally will make comparisons with their own salaries, and this will not be helpful.

But supposing that experts are employed who are chosen by reason of their experience, will that secure satisfactory results? There are such differences of opinion now apparent between these "experts" that anything like uniformity of results cannot at present be looked for.

And the differences in the principles and methods followed will give the Commission the opportunity to select from the mass the items least favorable to the corporations. On at least two points there will be a great variation on the part of the appraisers; overhead charges and depreciation.

As to overhead charges: an inventory—even if it should be more complete than any inventory which ever has been made—is only a surface indication of the total legitimate investment. Consider, for instance, an appraisal on the basis of inventory, made 20 years hence of the New York Central Terminal or the Hudson Tube. The inventory might not disclose 50% of the total cost.

As to depreciation: Notwithstanding opinions and court decisions to the contrary, I hold that no depreciation should be deducted from the cost to reproduce new, provided the plant is so maintained by current repairs and renewals as to give the public efficient and economic service. Here is where too many of the engineers and still more of the accountants confuse theoretical or estimated depreciation *to accrue*, with actual depreciation.

A certain man, speaking with authority, has stated recently that a railroad, as soon as put into operation, is reduced to 85% of its cost, and can be so maintained by current repairs and renewals. If, in a rate-making case, this estimate is made the basis for a depreciation deduction of 15% from cost, then we can assume that this is a *necessary* loss to the investor. If it is a *necessary* loss, it is a legitimate overhead charge. So we deduct it from the cost of plant, as such, and we add it in as one of the overhead charges. We have walked around the circle and are back again at the point of starting.

As applied to a rate-making case, the proposition of certain experts, able and experienced men though they are, that certain portions of the plant which are so renewed in part, year by year, as to maintain those parts at a uniform condition of efficiency should be depreciated 50%, is, in my opinion, indefensible. This again, as in the 15% case, means confiscation of investment. It is out of the power of the corporations to do more than maintain their plants at maximum efficiency. If renewals are so made each year as to prevent the depreciation of the quality of service, and if the current repairs and renewals and final renewals are paid for from income, the public is protected. The responsibility for renewals, current and final, rests upon the proprietors, not upon the public served. The investor (including the widow and orphan as well as the Wall Street magnate) should in turn be protected to the full measure of their legitimate investments.

From a long and wide experience in these matters I quite agree with you as to the doubtful value of the provision of the law which requires the appraisers to analyze the past financial transactions. In many cases the records will not be obtainable and in many other cases the records will be incomplete and not self-explanatory.

In the case of some of these corporations, if the appraisals in any measure approach accuracy, the results will be astonishing to the public and perhaps to the Commissions also. It seems to be the opinion of the uninformed, including some university professors of economics, that almost without exception the capitalization of the Public Service Corporations of the United States is heavily watered. But it will be found when the valuation is made that in many cases *the total capitalization does not equal the cost of plant alone.*

The truth is mighty and will prevail; but the trouble is that it sometimes takes a long time to assert itself, and while it remains in the background many innocent people get hurt.

ALEX. C. HUMPHREYS,
President Stevens Institute of Technology.

Hoboken, N. J.,
Mar. 25, 1913.

Retempered Mortar as a Finishing Coat for Concrete Surfaces

Sir—About six months ago, the writer cast about for some safe method of applying a cement-mortar finish coat to a well aged concrete structure, whose surface was not satisfactorily smooth.

In talking with a pair of old cement workers, it developed that for many years skilled workers have coated old concrete surfaces with comparatively thin wearing coats, of 1 : 1½, 1 : 2, or 1 : 2½ proportions, with noted success, their method being to allow the mortar to arrive at its initial set, then retempering with barely enough water to enable it to be easily troweled, and applying to the roughened, cleaned and moistened old surface.

Many severe tests of the method during the past few months, together with the examination of a pier thus coated 27 years ago, reported by R. C. Gowdy, Chief Engineer, Ft. Worth & Denver City Ry., and correspondence with E. A. Fisher, City Engineer, Rochester, N. Y., who specifies retempered mortar between old and green concrete, seem to bear out the "trade method" of the practical workers.

A general correspondence with several of our most noted professional brothers indicates considerable scepticism as to the merit of the process, and this is submitted for the purpose of bringing on discussion of the point, which, if worthy, is of large importance.

JOHN B. HAWLEY.

Fort Worth, Tex.,
Mar. 19, 1913.

The Tornado of March 23 at Omaha, Neb.

The tornado which struck Omaha, Neb., and neighboring places in Nebraska and Iowa, about 6:50 p.m. on Mar. 23, was one of the first disasters due to the heavy and widespread storms throughout the Central States during the week beginning on that date. While serious enough in itself, it afforded little information affecting engineering work, as no high office buildings and no bridges or other engineering works (with the exception of a timber trestle) were in the area swept by the wind. This area was at a considerable distance from the business district, the storm cutting diagonally across the western and northern portions of the city, through residence districts ranging from the wealthiest to the poorest character. The path of the storm across the city was about six miles long, and had the unusually great width of ¼ to ½ mile. Its direction and approximate area and the profile of the ground along the center line are shown in Fig. 6.

The day had been warm and sultry, with rain and some thunder and lightning. The wind was in general from the southwest, and at 5:30 p.m. from the south, but shortly before the tornado the wind shifted fitfully to nearly all points of the compass. Then the clouds became rapidly darker, and there was the greenish tinge of color usually associated with storms of this class, and finally the concentration of the clouds into a dense black mass.

FIG. 1. THE JOSLYN RESIDENCE AT 42D AND CHICAGO STS.

FIG. 3. VIEW AT 33D AND CALIFORNIA STS., OMAHA, NEB.

FIG. 2. THE SACRED HEART ACADEMY, 37TH AND BURT STS., OMAHA, NEB.

FIG. 4. ON NO. 33D ST., OMAHA, NEB., GROUP OF FRAME BUILDINGS OVERTURNED AND BLOWN AGAINST EACH OTHER IN A HEAP OF RUINS

FIG. 5. AT LAKE AND 24TH STS., OMAHA, NEB., WHERE BRICK AND FRAME BUILDINGS WERE WRECKED

The tornado struck the city about 6:50 p.m. The meteorological records are of only relative interest, since these were at the U. S. Weather Bureau office in the Post Office Building, which is more than a mile from the nearest limits of the path of the storm. However, we learn from the local officials that the precipitation for the previous 24-hour period (ending at 6 p.m.) was 0.18 in., while for the period of the storm it was 0.36 in. The maximum wind velocity recorded at the station for a 5-min. period was 32 m.p.h., while the actual maximum was 34 m.p.h. for two minutes. There was a sharp drop in temperature directly after the storm, and during the next few days there was a cold wave, with some snow.

The scene of the disaster was visited by a member of our editorial staff, and three features of interest were called to attention by Watson Townsend, City Engineer of Omaha. In the first place, the wreckage marking the path of the storm was continuous, although in many such storms there is the phenomenon of the tornado bounding from point to point and leaving intermediate spots practically untouched. In the second place, while the storm crossed rolling and hilly ground, the buildings on the lee side suffered as much as, or more than, those on the windward side and the summit. This may have been due in part to the fact that the lee slopes were occupied largely by buildings of the lighter class of construction, but it indicated also the way in which the storm followed the slope of the ground. In the third place, two or three buildings were found to have been moved actually against the general direction of the wind, shifting to the south or west on their foundations.

It is of interest to note that a substantial brick and concrete one-story substation on Leavenworth St. stood directly in this path and received no injury except that falling wires and cables pulled down the steel frame upon its roof. The timber trestle noted later on had a steel girder span on steel bents (over railway tracks); this span remained intact, with the trestle on each side blown down.

The center of the storm struck the western city limits at about 54th and Center Sts. and continued in a northeast direction to the residence district at Bemis Park, where it turned slightly to the east and then proceeded again northeast, leaving the city at about 14th and Spencer Sts., where the ground falls to the lowlands along the river. Along Leavenworth St. the total width of the path was about ½ mile, from 39th to 48th Sts. Near the corner of 48th St. a street car was overturned, trucks and all. Leavenworth St. is at the foot of a slope from the south and was lined with small lightly built frame buildings, many of which were not only blown down but literally blown to pieces, not a sign of a roof or wall being left and the wood being scattered far and wide, together with the furniture and contents. At 40th and Farnam Sts., a brick building was wrecked, and here a number of people were killed, having taken refuge in a garage which collapsed.

Beyond this the storm struck rising ground on which are some of the finest and most substantial residences in the city. These suffered comparatively little structurally, although chimneys and ornamental masonry work were carried away, roofs partly stripped, and interior damage was done by the wind which broke the windows. The trees here were either blown over or had all the boughs broken off. Around Bemis Park is another residence district, but having mainly frame buildings, and here the destruction was extensive. Beyond this, where the storm turned easterly, is a section of the poorer class of residences, which suffered severely. Along 24th St. both brick and frame buildings were wrecked, and among those which fell were a moving-picture theater and a pool room. Here numerous lives were lost. Along Sherman St. (as along Leavenworth St.) the wreckage extended for several blocks.

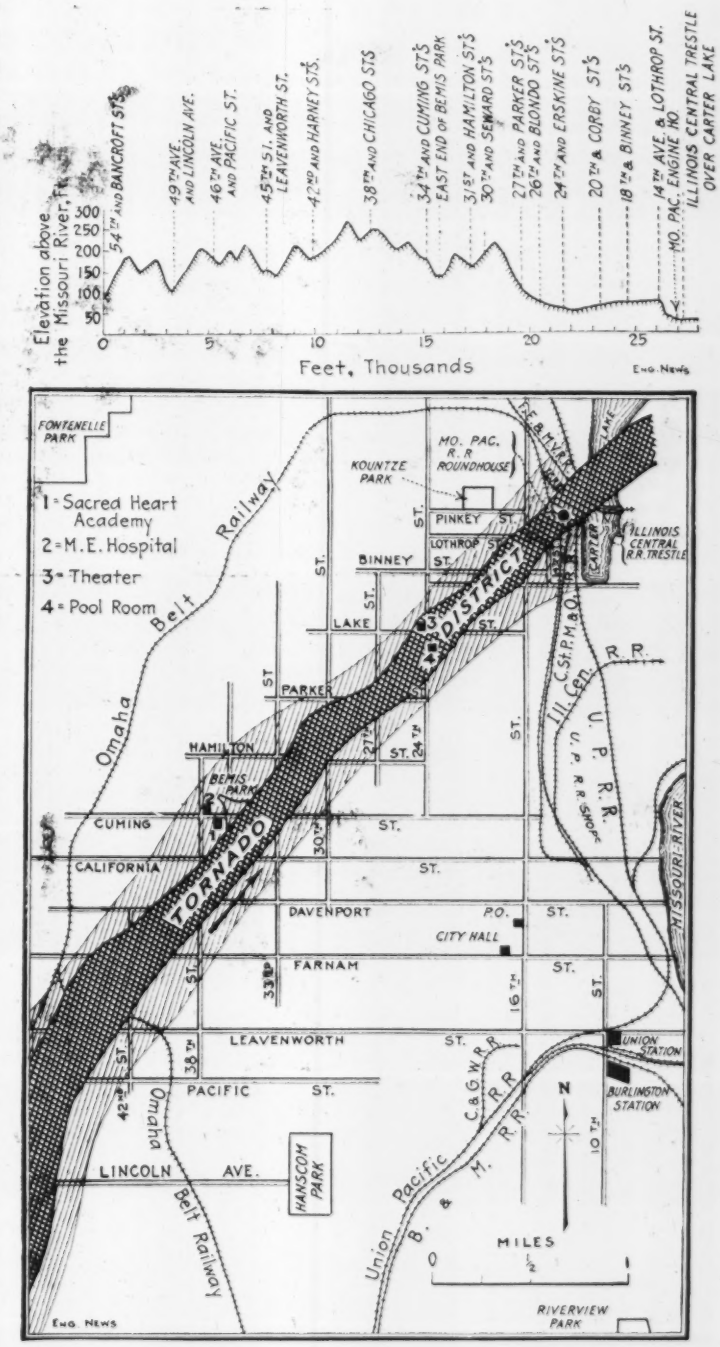

FIG. 6. MAP SHOWING PATH OF TORNADO AT OMAHA, NEB., AND PROFILE THROUGH CENTER LINE OF PATH

(The heavily shaded area includes all of that portion of the city in which the buildings were practically wrecked; the lightly shaded area indicates the partially damaged territory).

At 14th St. is the edge of a bluff which drops abruptly to the low ground along the Missouri River, much of which is occupied by railway tracks and yards. On this low ground was a new roundhouse of the Missouri Pacific Ry., a brick structure with timber roof. This was blown down and the wreckage caught fire (probably from the stoves used for heating), and the building was entirely destroyed. Across the low ground and the lake

(part of an old channel of the river) is a high timber trestle of the Illinois Central R.R., having a plate-girder span over the Chicago & Northwestern Lines. A part of the trestle was blown down, but the steel span (on steel bents) remained standing.

The points of greatest destruction were at 40th and Farnam Sts., and at 24th and Lake Sts., at both of which points brick buildings were wrecked. Fires broke out at several points but the fire department succeeded in getting them under control in spite of the difficulties. The rain also helped to check the fires. The electric wires and cables were in great confusion, many poles being blown over or broken off, and the wires stretched on the ground and tangled in the wreckage. Getting them in order so that light, telegraph and telephone service could be resumed was a serious task, which was tackled at once. Three or four lines of the street railway system were blocked by wreckage. The U. S. troops at Fort Omaha and the local companies of the state militia were put in charge of the wrecked district to prevent robbery and to keep out curious sightseers, who would only be in the way of the necessary work.

It is estimated that 150 persons were killed and 300 injured. A careful examination showed about 1700 houses damaged, of which 700 were destroyed or need entire rebuilding. This renders 2000 or 3000 people homeless, many of them losing practically all they possessed. Relief measures were undertaken promptly.

FIG. 7. VIEW AT 30TH AND HAMILTON STS.

FIG. 8. BUSINESS DISTRICT WHERE LOSS OF LIFE WAS HEAVIEST

The storm struck the small towns of Ralston and Yutan just west of Omaha, and passed through Council Bluffs and some small towns in Iowa after leaving the city. It appears that with the casualties in these places the total number of persons killed was about 185, and of persons injured, 350. There were other smaller windstorms in Nebraska, Iowa, Illinois and Indiana on the same night. One of these struck the northwestern part of Chicago, wrecking and overturning a number of buildings, and about six persons were killed. Another did a large amount of damage at Terre Haute, Ind.

The accompanying views indicate the amount of destruction in the path of the storm. The location of the various structures shown may be noted on the map in Fig. 6.

FIG. 9. WRECKAGE OF FRAME HOUSES

VIEWS IN THE TORNADO-SWEPT DISTRICT OF OMAHA, NEB.

(Cppyright, Underwood & Underwood)

The Ohio Valley Floods

Tornadoes and floods in a combination without parallel in the history of the United States wrought great havoc over an area a thousand miles long and several hundred miles wide, during the week beginning Mar. 23, 1913. The loss of life will probably total nearly a thousand. The damage already in sight aggregates many tens of millions of dollars. A spreading area of disaster may be reported during the current week and the following, from extreme floods in the lower Ohio and Mississippi Rivers. The stage of the upper half of the Ohio nearly reached (and at some points surpassed) the highest previous records as early as six days after the beginning of the torrential rains.

A tornado at Omaha, Neb., Sunday evening, Mar. 23, killed about 150 people and destroyed all houses over a long diagonal strip through the city; similar damage resulted in smaller towns in Nebraska, Iowa, Illinois and Missouri (Yutan, Berlin and Ralston, Neb.; Council Bluffs, Neola, Glenwood and Missouri Valley, Iowa; Sterling and Des Plaines, Ill.; Flag Springs, Mo.). At the same time great damage was done by a tornado in the southern part of Terre Haute, Ind., and in the village of Prairieton, 6 miles south, with a death list of about 25.

Floods exceeding all prior heights occurred in many streams of Indiana and Ohio on Mar. 25 to 27. Every river-valley city was inundated, many being partly destroyed; some 500 lives were lost in the two states. Incomplete reports give the following figures for lives lost: On the Whitewater River, Brookville (Ind.), 16. On the Wabash River, Peru (Ind.) and other towns, 25. On the Miami River, the cities of Piqua, Dayton, Middletown and Hamilton total about 200, of which Dayton has 100 to 150; the smaller places in the valley increase the total. On the Scioto River, Delaware and Columbus aggregate about 100 dead, with 65 to 75 at Columbus. On the Muskingum, Zanesville was the chief sufferer, with probably 50 dead.

All streams from the Wabash east to the Connecticut were in flood between Monday, Mar. 24, and Friday, Mar. 28, and many of them passed the highest stages known to have been reached in prior years.

All through railway communication across Ohio from east to west was broken, except for the line of the Lake Shore & Michigan Southern Ry. Six trunk lines connecting New York with Chicago and St. Louis were com-

FIG. 1. VIEW IN THE OUTSKIRTS OF DAYTON. WOODEN BUILDINGS MASSED TOGETHER BY THE CURRENT.

FIG. 2. A ROPE LINE FOR RESCUE WORK IN SWIFT CURRENT AT DAYTON

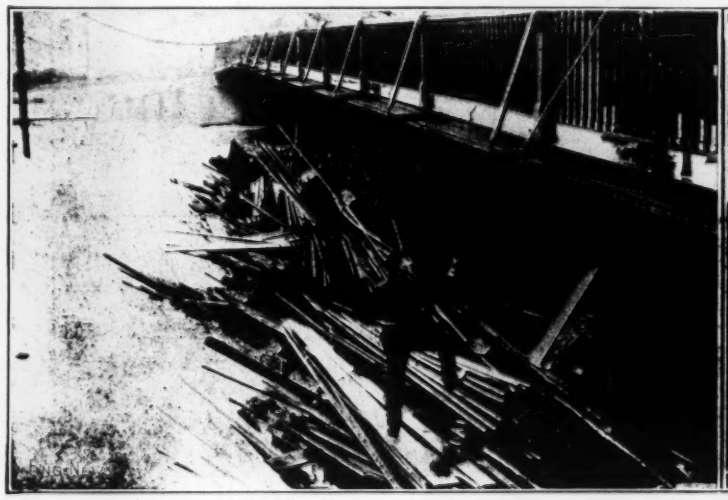

FIG. 3. DYNAMITING WRECKAGE PILED AGAINST BRIDGE SPAN, YOUNGSTOWN, OHIO

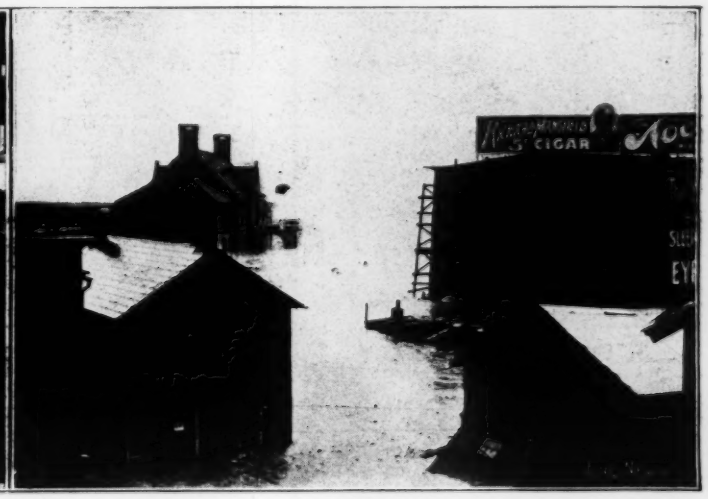

FIG. 4. THE BALTIMORE & OHIO PASSENGER STATION, YOUNGSTOWN, OHIO

pletely interrupted for three days: Baltimore & Ohio, the Fort Wayne and Panhandle lines of the Pennsylvania system, Erie, Big Four, and Nickel Plate. Wire communication was just as completely broken, and for periods of one to two days all cities chiefly affected were isolated except for highway communication. Many other railway, telegraph and telephone lines were interrupted, as far as Illinois, West Virginia, Pennsylvania and Connecticut.

Weather Conditions—Rainfall

Unusual meteorological conditions brought about this series of disasters. The four Weather Bureau maps for 8 a.m. Sunday Mar. 23 to Wednesday Mar. 26 are reproduced herewith in abridged copy; the isobars and wind arrows are given, and rain areas indicated by hatching, isotherms being omitted. As the maps show, a series of sharp low-pressure areas traveled across the continent at high speed, and throughout they maintained remarkably steep pressure gradients, amounting to nearly 0.15 in. per 100 mi. on Monday morning.

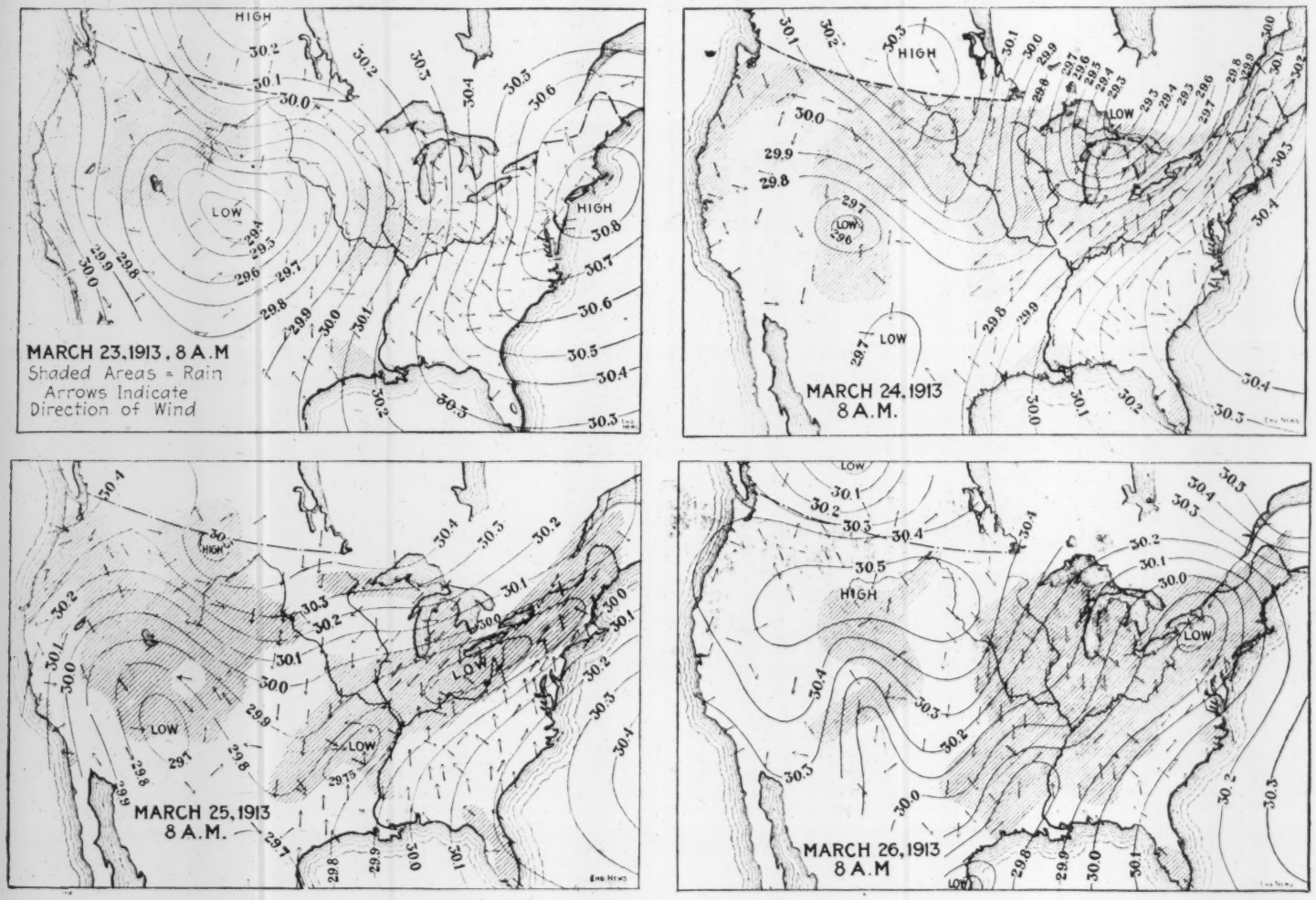

Fig. 5. U. S. Weather Maps, Mar. 23-26, 1913

Preceding the period covered by the maps, storms during the week beginning Mar. 16 were violent locally, but on Friday, Mar. 21, the whole country east of the Rocky Mountains was visited by blizzards, gales and tornadoes. Observed velocities of 88 mi. per hr. were reported at Detroit and Buffalo, 84 mi. at Toledo, O., and 64 mi. at Memphis, Tenn. There was widespread storm damage, but in addition a number of small towns in Alabama, Arkansas, Louisiana, Tennessee and Missouri were demolished by tornadoes, some 50 persons being killed, besides half a dozen deaths from falling chimneys and other storm-wind effects from Texas to Michigan. West of the Mississippi River, blizzards interfered with railway movement. Telegraph and telephone wires suffered extensive damage, and they were not yet restored to normal condition by Sunday, Mar. 23.

The primary cyclone area on Sunday evening, Mar. 23, carried violent tornado eddies along its southerly edge, one cluster of which caused the ruin on the Nebraska-Iowa border, while others appeared in Illinois, Missouri and at Terre Haute, Ind. As the low-pressure area moved northeast it became more concentrated (compare weather maps Mar. 23 and Mar. 24). An extraordinary rainfall occurred over the whole north-central area from Illinois to New York, with less heavy rain southwest and east of this area. These rains began Saturday, becoming concentrated Sunday and Monday, and continuing more or less until Thursday, Mar. 27. The north half of the valley of the Ohio River was deluged.

Roughly stated, over 5 in. of rain fell in three days on a region of about 150,000 sq.mi. between the Great Lakes and the Ohio. There was a precipitation of from 1 to 6 in. over the entire territory from the Missouri River east to the Alleghanies, and from the southern tier of states to the Canada line.

Table I gives the rainfalls at main stations from Sunday to Thursday, which covers practically the full period of precipitation except in the Atlantic States. Table II gives partial totals for 16 points in northern and central Ohio, where the heaviest rains fell. Both these tables were furnished us by the U. S. Weather Bureau.

The figures in these tables show clearly that the state of Ohio had the peak of the rainfall, and that the central

TABLE I. RAINFALL IN THE EASTERN MISSISSIPPI VALLEY, MARCH 23-27, 1913

(Figures in first five columns are precipitations in inches for 24 hr. ending at 8 a.m. of the date at head of column.)

	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Mar. 28	Total, in.
Chicago	1.36	0.08	0.04	M	0.00	1.48
Peoria	M	0.06	0.01	0.08	0.00	0.15
Springfield, Ill	0.72	2.22	M	0.24	0.00	3.18
Cairo	0.06	1.56	2.72	0.26	0.00	4.60
Notre Dame	1.42	0.84	0.00	M	M	2.26
Terre Haute	0.98	2.66	M	0.38	M	4.02
Indianapolis	1.52	3.40	0.46	M	0.00	5.38
Louisville	0.00	0.16	5.10	0.68	0.00	5.94
Lexington	0.00	0.20	M	1.56	0.01	
Toledo	2.44	2.68	0.34	0.68	0.02	6.16
Cleveland	1.96	2.88	1.26	0.98	0.10	7.18
Columbus	0.60	2.62	2.72	1.00	0.00	6.94
Cincinnati	0.40	2.24	1.75	0.80	0.00	5.19
Parkersburg	0.08	0.04	1.60	1.26	M	2.98
Pittsburgh	0.20	0.72	1.70	0.84	0.01	3.47
Erie	1.32	2.76	1.02	1.04	0.12	6.26
Detroit	1.30	1.26	0.24	0.60	0.06	3.46
Nashville	0.00	0.00	2.32	0.64	0.00	2.96
Memphis	0.08	0.00	1.60	0.18	0.00	1.86
Knoxville	0.00	0.00	0.24	2.16	0.00	2.40
Chattanooga	0.00	0.00	0.16	1.52	0.00	1.68

TABLE II. RAINFALL TOTALS AT CENTRAL OHIO POINTS, MARCH 23-26, 1913.

(Figures are total rainfall in inches for the week's flood storm, up to 8 a. m. of the date at top of column.)

	Mar. 24	Mar. 25	Mar. 26	Mar. 27
Piqua	6.68			
Sidney		6.60		
Fremont		6.12		
Tiffin		6.72		
Canton		3.22		
Coshocton		2.90		
Kings Mills		4.34		
Oregonia		4.00		
Zanesville			5.16	
Wooster			9.00	
Toboso			6.34	
Upper Sandusky			8.44	
Circleville				6.46
Bangerville				9.50
Bellefontaine				11.16
Marion				10.60

dletown and Hamilton, also, the rise to extreme height occurred about daybreak Tuesday, and the flooded area seems to have been an even greater proportion of the total area than at Dayton. By Tuesday forenoon all river-valley cities in Ohio south of the divide were flooded. The Columbus levees were overtopped Tuesday noon, and crest stage reached at 1.30 p.m.

Railway culverts were washed out Monday at a few places, and traffic interrupted or delayed. By detouring, trains were kept moving until Monday night and at some points to Tuesday morning. By the latter period all through rail traffic and a large part of the local traffic in Ohio was at a standstill.

Recession of the floods began Tuesday evening to Wednesday, though not until Thursday were the rivers down to levels comparable with ordinary flood stages.

River Stages—Only a few figures are available at the present writing as a measure of the high water. At Terre Haute, Ind., not far above the mouth of the Wabash, flood stage is 16; the Weather Bureau gage readings showed 7 ft. on Mar. 23, and 31.2 ft. on Mar. 27, a rise of 24 ft. in four days. At Cleveland, Ohio, E. B. Thomas reports the Cuyahoga River to have been 4 ft. above normal at Main Ave. bridge, one-half mile mile from the river mouth, and 19½ ft. above normal at the head of navigation, 5½ miles from the lake. The Scioto River at Columbus, Ohio, had a flood flow of 93,000 sec.ft. above the junction with the Olentangy. This

Fig. 6. Part of the Hudson River at Watervliet, N. Y., Opposite South Troy, Mar. 28

Fig. 7. A View on River St., Troy, N. Y., Mar. 28.

Flood Views on Hudson River

(From photographs copyrighted by Underwood & Underwood).

part of this state (embracing the Erie-Ohio divide and on either side the headwaters of the streams flowing to north and south) received the most concentrated deluge, 8 to 11 in. falling in three days. Remembering that the intense precipitation was not local but statewide, the source of the great floods throughout the Ohio river valleys can be understood.

Unusually high water was reported as early as Monday noon from points in northeastern Indiana (Fort Wayne, Elwood, Marion, Kokomo, Winchester, Huntington, Wabash) and northwestern Ohio (Fremont, Findlay, West Liberty). These flood reports came from the headwaters districts. Late Monday night all streams were at record heights. Early Tuesday morning the Dayton levees broke and the water rapidly spread over the business section, flooding practically two-thirds of the city. At Mid-

is an excess of 40,000 sec.ft. over the previous high-water record of 1898. Levees which had been built 6 ft. higher than the record high water were overtopped for many miles. At Circleville, above Columbus, the stage was reported 3 ft. higher than before known. At Franklin, Ohio, the Miami reached a maximum stage about 3 ft. above the previous high record, on Tuesday evening. At Dayton, where the flood reached its crest at midnight Tuesday, the highest stage is claimed to have been 10 to 20 ft. above prior records, but no definite levels can yet be obtained. At Hamilton, Ohio, it is said that some points not covered by the highest previous flood were submerged 10 ft.; substantially the whole city was covered by the water.

As to Eastern points, outside the area of heaviest rainfall, the Genesee at Rochester rose higher than at any

previous time since 1864, according to advices from E. A. Fisher, City Engineer. The Hudson below the Troy dam reached a stage of 22½ ft., which apparently is well above prior records. At Mechanicville, some fifteen miles above, the maximum discharge of the Hudson was estimated at 81,000* sec.-ft., as against 70,000 for the greatest discharge known before.

The Ohio River reached a crest-level of 30.4 ft. at Pittsburgh early Friday, Mar. 28. This height is within a foot of January's flood, 31.3 ft. (see ENGINEERING NEWS, Jan. 30, 1913), but is 5 ft. below the record, 35.5, reached in 1907. The highest level at Wheeling, W. Va., was reached about noon Friday, 51 ft. gage. Cincinnati had a crest stage of 69.8 on Apr. 1, against a record stage of 71 ft. Gallipolis and Portsmouth, between Wheeling and Cincinnati, report floods above the highest records, possibly due to flood flow of near-by tributaries.

Railway service, by highly concentrated effort, was restored fragmentarily late in the week, few points being reached before Thursday, and none of the broken main lines being operated before Saturday. The Pittsburgh, Ft. Wayne & Chicago resumed through operation to Chicago Saturday, with a small detour over Erie tracks. On the same day the last of the flood towns were reached by trains. The Erie resumed New York-Chicago through service Saturday morning, having repaired its washed-out embankments; it reports no bridges destroyed. The Panhandle was not connected through by Monday, Mar. 31, being cut at Dennison, Ohio. Broken railway lines outside of Ohio were restored much more rapidly with isolated exceptions; the New York Central's main line in the Hudson River Valley, submerged just below Albany, was not in use until Sunday, Mar. 30.

Damage to engineering structures cannot yet be reported. A number of railway bridges and a large number of street and road bridges were destroyed, among them some large and important ones. No important dams or reservoir embankments appear to have failed; the river dams at Middletown and Columbus and the reservoir dam at Akron, all rumored to have been destroyed, are standing, although there was a breach through the natural embankment at the latter place. Buildings, shops and factory plants form the largest item of structural damage or destruction. Municipal engineering structures are perhaps next as to value destroyed. Sewer and water-supply systems in all the flooded cities were wholly or partly put out of commission, and estimates of the damage cannot yet be obtained (see also letter of W. H. Dittoe, below). The flooding of filter plants and pumping unpurified water through the mains implies further damage, whose importance cannot be fully foretold at present. Conditions along the New York barge canal are briefly mentioned on p. 697.

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Flood Protection at Paris, France, since the destructive floods of 1910, has only consisted in repairing the damage caused by those floods, at a cost of about $400,000. Nothing has been done to carry out remedial work by raising the quays and facilitating the flow of water through Paris by widening the narrow parts and deepening the river, the estimated cost of which has been put at about $7,000,000. Given the same conditions which existed in the Fall of 1909, and the Spring of 1910, there is no reason to suppose that the same amount of destruction would not be caused to the city of Paris.

*See report of Consulting Engineers in "Report of State Engineer on Barge Canal," 1901, p. 177: "It is reasonably certain that a discharge of 60,000 cu.ft. per sec. is not likely to be exceeded at Mechanicville."

Notes on the Floods in Ohio and the Related Work of the Ohio State Board of Health

By W. H. Dittoe*

At this time (Mar. 29) it is almost impossible to give any definite information concerning the damage done by the floods which have been especially severe in the Great Miami, Scioto and Muskingum Rivers.

At Columbus a number of highway bridges were destroyed and owing to several breaks in levees the west side of the city was entirely flooded to depths reaching 15 ft. The property loss in this section was great. The gage height of the Scioto River reached 22.9 ft., about 1½ ft. higher than the 1898 record. A rumor that the storage dam above the city had broken was entirely erroneous. A rough estimate gives the discharge over the dam as 80,000 cu.ft. per sec.

At Dayton the entire central business and residence sections were flooded, with water reaching 15 to 18 ft. in depth. The property loss there has been estimated from $15,000,000 to $30,000,000. Breaks in the levees added to the destruction.

The water-supply at Dayton was thrown entirely out of commission and its reconstruction cannot be commenced before Monday, Mar. 31. Drinking water for Dayton is being furnished by the Springfield water-supply, presumably by means of tank cars.

The Zanesville water-supply is out of commission due to the high water but will probably be placed in service as soon as the water subsides.

The Columbus water-supply was temporarily out of commission for about 24 hours, due to a break in one of the discharge mains. The easterly part of the city is now being supplied and the westerly section will be served in a day or so.

Thus far we have not ascertained that any of the state [canal] reservoirs have failed. James E. Marker, state highway commissioner, was placed in charge of the various reservoirs.

The State Board of Health, through its secretary, Dr. E. F. McCampbell, immediately organized a staff to deal with the situation and it was arranged that a sanitary engineer and medical inspector should visit the cities most affected. The general work of the inspectors has been to organize the local departments, to reëstablish quarantine and to reëstablish sanitary conditions within the flooded districts. Visits have been made to Dayton, Zanesville, Newark, Springfield, Urbana, Xenia, Delaware, Piqua, Troy, Middletown, Miamisburg, Hamilton and a number of other cities. We do not anticipate that serious epidemics will result from the floods.

The following rules for reëstablishing sanitary conditions and for the control of communicable diseases in the flooded districts were sent by the State Board of Health to the local health boards of the various cities affected.

Rules of the Ohio State Board of Health for Reëstablishing Sanitary Conditions within Flooded Districts

(1) Reëstablishment of water-supply.
(2) Disinfection.
(3) Removal of putrescible matters.
(4) Cleaning of streets and walks.

*Chief Engineer, Ohio State Board of Health, Columbus, Ohio.

(5) Reëstablishment of sanitary conveniences.
(6) Cleaning of yards, houses and buildings.

All of the above should be accomplished in general in the order named. If possible, all of the remedial measures should progress simultaneously, but this may be impossible.

(1) Reëstablishment of water-supply.
   a. Boil all water used for drinking purposes.
   b. If fuel cannot be obtained, municipality must distribute [water] supply of assured sanitary quality by tank wagons, barrels or otherwise.
(2) Disinfection. (Note below for disinfectants.)
   a. Spread lime generously over flood deposits which cannot immediately be removed.
   b. Whitewash interior of buildings after deposits have been partially removed by scraping by the owner or municipality.
   c. Disinfect fecal matter in vaults and upon surface, which cannot be immediately removed, by use of calcium hypochlorite.
   d. Disinfect dwellings in which a contagious disease has existed by the use of formaldehyde.
(3) Removal of putrescible matters.
   a. Fecal matter, dead animals, garbage and other putrescible wastes should be immediately removed, if possible in wagons, and properly disposed of.
   b. Fecal matter and other semi-liquid wastes may be discharged into existing sewers through manholes.
(4) Cleaning of streets and walks.
   a. By flooding if water-supply is available.
   b. By scraping and brooming if water-supply is not available.
(5) Reëstablishment of sanitary conveniences.
   a. Where sewer is available and can be used. If dwellings have no indoor sanitary conveniences or water-supply is not available build temporary closets over manholes.
   b. Where sewer is available but cannot be used. Provide watertight metallic covered receptacles to be used until other provision is made, and to be emptied into nearest sewer or vault at the direction of the health department.
(6) Cleaning of yards, houses and buildings.
   a. Owner shall scrape ceilings, inside and outside walls, floors, walks and yards, piling material in street. If owner is unable to accomplish this the municipality should proceed with the work.
   b. Ceilings, walls and floors should be whitewashed. Walks and yards should be sprinkled with lime.
   c. Cleaning by owner may be completed after whitewash has dried.
   d. Provision for pumping flooded cellars must be made by municipality.

DISINFECTANTS

Lime:

If lump lime is used it should be slaked to a dry powder, which should be scattered freely over deposits.

If hydrated or slaked lime is used apply as before.

For whitewash mix hydrated or slaked lime with twice its volume of water to proper consistency, to apply with brush.

Hypochlorite:

Make solution from paste in proportion 5 lb. of powder to 1 bbl. of water (30 gal.).

Use one barrel of such solution to 1 cu.yd. of fecal matter.

Note—If fecal matter is in solid condition remove immediately without use of hypochlorite. If in semi-liquid condition disinfect, stirring to accomplish mixture.

Formaldehyde:

To be used in accordance with regulations of local health department.

Rules of the Ohio State Board of Health for the Control of Communicable Diseases in Flooded Districts

(1) Where it is necessary to remove persons quarantined for contagious diseases or for having been exposed thereto, especially smallpox, diphtheria and scarlet fever, they must be taken in charge by the board of health and removed to separate buildings, and physicians, nurses and food supplied.

(2) All persons, societies or institutions taking in refugees from flooded districts should immediately notify the board of health so that an investigation can be made to determine if any such refugees have a communicable disease or have been exposed thereto. A register of all persons coming under the supervision of the board of health should be kept.

(3) All refugees sent to large buildings or volunteered homes must be examined by a physician with especial reference to sore throat, fever and eruption. All suspects should be placed in a detention building or kept under observation by the board of health.

(4) All exposures to and persons coming from districts where smallpox exists must be immediately vaccinated.

(5) Typhoid patients should be carefully guarded and their feces and urine disinfected immediately.

(6) Anti-typhoid inoculation will prevent typhoid fever and should be practiced where possible.

(7) The board of health and water-works officials must give continuous warning to **BOIL ALL WATER FOR DRINKING PURPOSES** where the supply is from private wells in flooded areas or where the public supply is taken from a stream or from wells that are in a flooded area. Boiling should be continued until notice from the board of health.

(8) Physicians should volunteer for medical and sanitary work and place themselves at the disposal of the board of health and coöperate with it.

Severe epidemics of typhoid fever and scourges of other contagious diseases often follow in the wake of floods. All precaution must be taken to prevent this.

Flood Damage along New York State Barge Canal

High water along the line of the New York State Barge Canal did considerable damage to contractors' plants and to work under construction, but did not seriously damage many of the finished structures. The State Engineer has deferred giving out any official statement of the extent of the damage until authentic information has been received from all points along the canal. He has, however, taken occasion to deny a widely circulated report to the effect that $50,000,000 damage had been done to the Canal structures and equipment.

As far as can be now ascertained, most of the injury along the line of the Barge Canal has been the washing away of embankments and the possible filling of channels. At Yosts, on the Mohawk River, one of the movable bridge dams of the type described in ENG. NEWS, Dec. 8, 1910, p. 611, was somewhat damaged. The gates of the dam were down and the flood, rising during the night, washed against them so much dèbris that the gates could not be raised. Some of the gate frames were bent back out of line. It is not thought, however, that the damage was very serious.

Hearing on Engineers' License Bill at Albany (by telegraph)—At the hearing, on Apr. 1, before the Assembly Committee on Education, having in charge the bill before the New York legislature to license engineers, a large delegation of engineers appeared in opposition to the bill. Among the speakers in opposition were State Engineer Bensel, R. D. Mershon, President of the American Institute of Electrical Engineers, Prof. W. R. Whitney, Chairman of the Research Department of the General Electric Co., Frederick Molitor, Prof. Olin B. Landreth, of Union University, Frank J. Sprague and Prof. Arthur M. Greene, Jr., of Rensselaer Polytechnic Institute. Letters were also read from Alfred Noble and Prof. William H. Burr, opposing the bill. The speakers in favor of the bill were Messrs. Eliot, Weinberger, Zartmann, Schoonmaker and Seely. The chief arguments of the speakers opposing the bill were the obstruction to general engineering practice, were licenses to be required by each State; that there was no demand for the passage of the bill from the public, nor from the engineering profession; that the bill had originated with a small society called the Technical League, the purpose and membership of which are kept secret, and which has no recognized standing in the engineering profession. It was further argued that the state should protect the public against incompetent engineering work by examining the work itself rather than the men. The Civil Service examinations for engineers engaged on public works, and the examination of plan for public works by state authorities are better protection than any form licensing. As the present bill licenses anyone to practice as an engineer who has had three years' experience merely in the inspection of engineering work, the result would be to lower rather than raise the standards of the profession. Members of the Committee seemed to favor the bill.

A Tall Brick Chimney of a manufacturing plant at Des Plaines, Ill., was blown over by the wind on Mar. 24. The chimney fell on the caboose of a passing freight train on the Minneapolis, St. Paul & Sault Ste. Marie Ry., causing the deaths of two trainmen and serious injury to another.

Aëroplane Accidents on Mar. 28, caused the deaths of three army officers: Lieut. Brossard, of the French Army, was killed at Verdun, France, when the motor of his aëroplane burst at an altitude of 2500 ft.; two Japanese army officers, Lieuts. Tokuda and Kimura, were killed at Tokyo, while giving an exhibition flight before a large gathering of Members of Parliament.

Hydro-Electric Power Companies doing an interstate business are not yet subject to federal control. In our issue of Mar. 20 last, p. 595, we quoted a clause from the River and Harbor Appropriation Bill as passed by the Senate which made such companies subject to the Interstate Commerce law on their interstate business. This clause was eliminated from the bill by the conference committee, however, so that it does not appear in the law as finally enacted.

The British Steamship "Lugano" Grounded on Ajax Reef, near Key West, Fla., on Mar. 9, and shortly afterward her 110 passengers were transferred to the wrecking tug "Rescue," which answered distress signals. The "Lugano" was badly damaged by the rocks and shipped a good deal of water, but her crew stayed in an attempt to save the vessel. This is a Lloyd Line boat plying between Liverpool and Havana by way of Spain Shortly after this accident another British steamer the "Howth Head" went aground on the nearby Molasses Reef.

Two Railway Automatic Stops are to be tried out by the New York, New Haven & Hartford R.R. in accordance with its recent offer of $10,000 for a successful development of such a device (see "Engineering News," Dec. 9, 1912). It is reported that these two devices are somewhat similar and both give promise of accomplishing the general purposes desired, though neither one meets all of the eighteen requirements specified by the New Haven road in accordance with the desirable characteristics outlined by the Block Signal & Train Control Board of the Interstate Commerce Commission (see "Engineering News," Feb. 20, 1913). One of these stops is being developed by the Union Switch & Signal Co., of Swissvale, Penn., and the other by the International Signal Co., of New York City.

The cash prize noted is of course unimportant and the cost of development promises to be several times any such amount. However, under the conditions of the invited competition, the company agreed to assist the inventor by contributions of money or by use of tracks or both, provided the device selected for development appeared in the judgment of the road's signal engineer to have sufficient merit. In all, 1574 applications were received but most of them were not prepared in accordance with the conditions governing the competition. Only 5% were worthy of consideration at all, and of these only the two mentioned above met with sufficient approval to warrant experiments.

One inventor wrote that his device would not be dangerous to passengers but would probably kill the engineer and fireman. Another man proposed to use a heavy spring hook, which would rise up from the roadbed and catch hold of an axle on one of the cars. Applications were received from all over the world, and the competitors represented nearly every walk in life; four of the inventors were in jail, and four in insane asylums.

Subjects for Economic Prizes for the "best studies in the economic field" have just been announced for the tenth year (1914) by Prof. J. Laurence Laughlin, of the University of Chicago, chairman of a committee of five. As heretofore, the fund for the prizes is provided by Hart, Schaffner & Marx, of Chicago. Any American may contest for the prizes of $1000 and $500 in Class A except college undergraduates, but for the $300 and $200 prizes in Class B the contestants must be college undergraduates at the time the papers are sent in. The judges reserve the right to award the Class A prizes to Class B contestants "if the merits of the papers demand it." Subject to the approval of the committee, contestants may choose their own subjects; or without such approval they may choose from a long list of subjects listed by the committee in former years, or from any of the following eight subjects suggested by the committee for 1914:

1. The competitive relations of the Suez and Panama Canals.
2. A study of the economic conditions preceding and following the crisis of 1907.
3. Price regulation by governmental authority.
4. A theory of public expenditures.
5. A study of shipping combinations in ocean transportation and their influence on rates.
6. How far has the regulation of freight charges affected the development of railways in the United States?
7. A study on the changes of modern standards of living.
8. A study of the cost to the United States of its possession of the Philippine Islands.

The papers must be sent to Prof. Laughlin on or before June 1, 1914. The announcement has been made thus early to enable students to utilize summer vacations. Further details may be obtained from Prof. Laughlin.

The Sanitary District of Chicago has received an order from the Secretary of War to reduce the amount of water now being diverted from Lake Michigan by the drainage canal. The Trustees of the district, however, hold that the Secretary of War is without jurisdiction in regard to the flow of water in the drainage canal and the old Illinois & Michigan Canal. It is claimed that the Sanitary District is acting under the authority of a statute of the State of Illinois, and must comply with the requirements of this statute until it is set aside by some superior authority. It is presumed that action will be brought by the United States Government in a court of equity.

New Developments in Panama Canal Slides—On the night of Mar. 12-13, the break on the east bank of the canal, opposite Culebra, which first moved into the canal on the night of Feb. 5, again made another rapid movement downward and toward the canal. The bottom of the canal, near the center, was heaved up for a distance of about 1000 ft., and to a maximum vertical height of about 30 ft., destroying five tracks in the bottom of the canal, overturning steamshovel No. 220, and partly tipping over steamshovel No. 205. Only one track remained in commission after the break had ceased moving, but a second one has since been connected, so that there are now two tracks in use on the west side of the canal. Two steamshovels were set to work at once removing that part of the slide which had heaved up at the bottom, and satisfactory communication was again restored on Mar. 17. ["Canal Record," Mar. 19, 1913].

Order for the Largest Direct-Current Generators, noted in our issue of Nov. 7, 1912, as having been designed (though not built) by the General Electric Co. for the Southern Aluminum Co., has been canceled. There were to be installed at Whitney, N. C., seven vertical waterwheel units, each driving a 5000-kw. 20,000-amp., 250-volt, 170-r.p.m. generator.

It is reported that the Southern Aluminum Co., which uses French capital, has abandoned its proposed hydro-electric development at Whitney, N. C., and may build a new dam several miles below the present site on the Yadkin River. There is apparently some question whether this lower development will be pushed. The Whitney development has passed through many vicissitudes since its beginning in 1901. Work was promoted first by the late George Whitney, of Pittsburgh, and there was unusually expensive construction. Some 4½ miles of canal were necessary to develop a head of 120 ft. and make available 45,000 hp., but this was available for only 10 to 12 hr. In 1907 the old enterprise was abandoned, although the hydraulic works were nearly completed. The same French capitalists that were interested in the Southern Aluminum Co. were interested in this power company, which is reported to account for the latter company taking over the works. It is reported that the electrolytic process requires 24-hr. power and that the old development has not shown possibilities of sufficient storage.

PERSONALS

Mr. Mason H. Baker, Assoc. M. Can. Soc. C. E., has resigned as City Engineer of St. Thomas, Ont., to become City Engineer of Prince Albert, Sask.

Mr. J. K. McGrath, formerly with the Maryland State Roads Commission, has been appointed Principal Assistant Engineer of Paving of the city of Baltimore, Md.

Mr. B. G. Horton has been appointed Superintendent of Locomotive Fuel Service of the New Orleans, Texas & Mexico R.R., with headquarters at De Quincy, La.

Mr. O. Tefteller has been appointed Superintendent of Locomotive Fuel Service of the St. Louis, Brownsville & Mexico Ry., with headquarters at Kingsville, Tex.

Mr. J. E. Chamberlain, for some years connected with the engineering department of Evans, Almirall & Co., Engineers and Contractors, New York City, has resigned.

Mr. R. L. Stewart, formerly Master Mechanic of the Chicago, Rock Island & Pacific Ry., at Trenton, Mo., has been appointed Master Mechanic of the Chicago Terminal of the same railway.

Mr. C. C. Blood, Office Engineer of the Portland, Eugene & Eastern Ry., Portland, Ore., has resigned to accept a position with the maintenance-of-way department of the Northern Pacific Ry.

Mr. Fred Hooker, formerly Traveling Engineer, has been appointed Superintendent of Locomotive Fuel Service of the St. Louis, Brownsville & Mexico Ry., with headquarters at Kingsville, Tex.

Mr. Samuel W. McClure has been appointed Resident Engineer of the Lake Shore & Michigan Southern Ry., at Erie, Penn., succeeding Mr. H. W. Fenno, transferred, as noted in our issue of last week.

Mr. Frank Hopper, formerly Division Master Mechanic of the Chicago, Rock Island & Pacific Ry., at Estherville, Iowa, has been appointed Master Mechanic of the Duluth, Winnipeg & Pacific Ry., at West Duluth, Minn.

Mr. E. E. Larkins, Assoc. M. Am. Soc. C. E., Engineer of Bridges and Sewers, at Omaha, Neb., has resigned in order to take charge of some heavy reinforced-concrete construction work for the Larkin Soap Co., at Buffalo, N. Y.

Mr. J. E. Saunders, until recently Assistant Signal Engineer of the Atchison, Topeka & Santa Fé Ry., Topeka, Kan., is now Office Engineer with the signal department of the Delaware, Lackwanna & Western R.R., at Hoboken, N. J.

Mr. C. F. Smith, Assistant Superintendent of the Oregon Short Line R.R., at Nampa, Idaho, has been promoted to be Superintendent of the Montana division, with headquarters at Pocatello, Idaho, succeeding Mr. W. R. Armstrong, resigned.

Mr. J. L. Doupe, Chief of the land department of the Canadian Pacific Ry., has been appointed Chief Surveyor of the operating and maintenance-of-way departments, under the new organization described in our personal columns of Feb. 27.

Mr. J. H. Roach, Assoc. M. Am. Soc. C. E., formerly with the Robt. Grace Construction Co., New York City, has been appointed Assistant Engineer of Construction of the Lake Shore & Michigan Southern Ry., with headquarters at Cleveland, Ohio.

Mr. Kenneth C. Grant, M. Am. Soc. C. E., of Pittsburgh, Penn., was married, Mar. 26, to Miss Janette Adams Garner, daughter of Mr. and Mrs. John Lake Garner, of Los Angeles, Calif. Mr. and Mrs. Grant are spending their honeymoon in Honolulu, H. I.

Mr. J. C. Muir, formerly Superintendent of the Chicago & Eastern Illinois R.R., at Danville, Ill., has been appointed General Superintendent of the Chicago, Terre Haute & Southeastern Ry., with headquarters at Chicago, Ill., succeeding Mr. M. W. Wells.

Mr. A. J. Astroe, Chief Draftsman of the Portland, Eugene & Eastern Ry., has been promoted to be Office Engineer, at Portland, Ore., succeeding Mr. C. C. Blood, resigned, as noted elsewhere. Mr. Ward H. Rupp, former Right-of-way Engineer, succeeds Mr. Astroe.

Messrs. C. P. Howard, M. Am. Soc. C. E., former Assistant Engineer of the Illinois Central R.R., at Chicago, Ill., and Shelby S. Roberts, M. Am. Soc. C. E., former Division Engineer of Construction, Illinois Central R.R., Chicago, Ill., have formed a partnership with offices in the Transportation Bldg., Chicago, for the general practice of civil engineering, specializing in railway surveys, construction and operation.

Mr. W. F. Steffens, Assoc. M. Am. Soc. C. E., formerly Engineer of Structures of the Boston & Albany R.R., Boston, Mass., has been appointed Assistant Chief Engineer of the Chesapeake & Ohio Ry., with headquarters at Richmond, Va. Mr. Steffens graduated from the Massachusetts Institute of Technology in 1898 and was at one time Engineer of Bridges and Buildings of the Carolina, Clinchfield & Ohio Ry., in Tennessee.

Mr. R. C. Hardman, Assoc. M. Am. Soc. C. E., has resigned his position as Civil Engineer and Superintendent of Construction with the War Department, at Fort Huachuca, Ariz., to become connected with the engineering staff of Mr. E. C. van Diest, M. Am. Soc. C. E., Consulting Engineer, 412 Mining Exchange Bldg., Colorado Springs, Colo. Mr. Hardman was formerly Provincial Supervisor and District Engineer, Bureau of Public Works, in the Philippine Islands.

Geo. T. Gwilliam, M. Am. Soc. M. E., formerly connected with the Hess-Bright Manufacturing Co., of Philadelphia, is President of the Gwilliam Co., makers of ball bearings of various types and other supplies for automobiles, etc., with headquarters at Broadway and 58th St., New York City. The other officers of the company are: John Gwilliam, Vice-President; George T. Gwilliam, Jr., Treasurer; Charles R. Norris, formerly of U. S. N., Secretary; S. Fabian Goodman, General Manager.

Mr. George B. McGinty, former Assistant Secretary of the Interstate Commerce Commission, has been appointed Secretary, succeeding Mr. John H. Marble, appointed a member of the commission, as noted in our issue of Mar. 13. Mr. McGinty was born in Monroe County, Ga., in 1878. He has spent a number of years in the clerical departments of the Atlantic Coast Line R.R., the Georgia R.R. and the Southern Ry. He first entered the service of the Interstate Commerce Commission in 1908, in the division of statistics and accounts.

Mr. H. E. Talbott, M. Am. Soc. C. E., Consulting Engineer, of Dayton, Ohio, has been appointed by Governor Cox, of Ohio, Chief Engineer of the military zone now under martial law, established by the State National Guard in the flooded districts about Dayton. According to newspaper dispatches, Mr. Talbott has announced that four departments have been created under his jurisdiction, with an Assistant Engineer in charge of each. One division will have charge of rebuilding the streets and alleys, another the levees along the rivers, another the sewer system and the fourth will have charge of the reconstruction of bridges.

Mr. J. J. Bernet, Assistant Vice-President of the Lake Shore & Michigan Southern Ry., and other Western lines of the New York Central System, has been elected Vice-President of these lines in charge of operation, maintenance and construction, with headquarters at Chicago, Ill. Mr. Bernet was born in Erie County, New York, in 1868, and received his education in the public schools of Buffalo, N. Y. At the age of 21 years he entered the service of the Lake Shore & Michigan Southern Ry. as a telegraph operator. He was promoted through the grades of train dispatcher, trainmaster to be Division Superintendent in 1905. A few months later he was made Assistant General Superintendent. On Oct. 1, 1906, he was promoted to be General Superintendent with headquarters at Cleveland, Ohio, where he remained until June 1, 1911, when he was made Assistant to the Vice-President of the New York Central Lines west of Buffalo.

Mr. C. F. W. Felt, M. Am. Soc. C. E., Chief Engineer of the Atchison, Topeka & Sante Fé Ry., has been promoted to be Chief Engineer of the entire Sante Fé System, succeeding Mr. C. A. Morse, M. Am. Soc. C. E., whose appointment as Chief Engineer of the Chicago, Rock Island & Pacific Ry. was noted in our issue of last week. Mr. Felt was born in Salem, Mass., Apr. 29, 1864. He was educated at the Massachusetts Agricultural College at Amherst, and entered the railway service in 1886 as an axman on construction with the Atchison, Topeka & Sante Fé Ry. in Kansas and Colorado. He was shortly afterward promoted to be rodman and a year later to be a Bridge Engineer. In the spring of 1888 he was a levelman with the Denver & Rio Grande R.R., and then spent a year as instrumentman with the Arizona & Southeastern R.R. After a year as transitman with the Topolobampo R.R., in Mexico, he returned to service with the Santa Fé Lines as Resident Engineer of the Northern division of the Gulf, Colorado & Santa Fé Ry., at Cleburne, Tex. In 1892-93, he was Office Engineer of the Rio Grande Southern Ry., returning to the Gulf, Colorado & Santa Fé Ry. in February, 1893, as Division Engineer. Later he was Resident Engineer of the same railway at Galveston, Tex., and for several years following 1896 he was Chief Engineer.

Mr. A. T. Hardin, Assoc. M. Am. Soc. C. E., Assistant Vice-President of the New York Central & Hudson River R. R., has been elected Vice-President in charge of operation, maintenance and construction of the New York Central Lines east of Buffalo, with offices at the Grand Central Terminal, New York City. Mr. Hardin is a native of South Carolina, where he was born in 1868. At the age of 14 years he was a telegraph operator on the Richmond & Danville R.R. For the following eight years he was agent and stenographer with the same railway, giving up his position in 1890 to attend the University of South Carolina, from which he was graduated four years later with the degree of Civil Engineer. From 1894 to 1898 he was with the maintenance-of-way department of the Southern Ry. Mr. Hardin's service with the New York Central Lines began in 1898 as Supervisor, and a short time later, Division Engineer of the Eastern division of the New York Central & Hudson River R.R. In September, 1899, he was promoted to Engineer of Track, and continued in this position until February, 1903, when he was made Engineer of Maintenance-of-way. In 1905, he was changed to the operating department as Assistant to the General Manager, and after a year's experience in this capacity Mr. Hardin was promoted to be Assistant General Manager, holding this office until April, 1912, when he was promoted to be Assistant Vice-President.